CIF # 1089 – Next Gen Recycling Technologies

ECOCOMPASS

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Introduction

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Short List Recommendations

Technology	Manage / Measure Contamination	Improve Bale / Commodity Quality	Time to Implement	Cost to Implement (Payback Period)
In-Bin Remote Sensors and Camera	Identifies contamination at source	Lowers contamination in bales	Short	Low; Cameras and software
RFID Equipped Trucks and Bins	Track households with contamination	Lowers contamination in bales	Medium	Medium; Sensors and antenna can be added
Front-Load Automated Collection Truck	Allows for visible inspection	Lowers contamination in bales	Medium	High; new trucks required
Black Plastic Optical Sorter (not by resin)	Indirect	Remove black plastics from bales	Medium	Medium; New Optical Sorter required

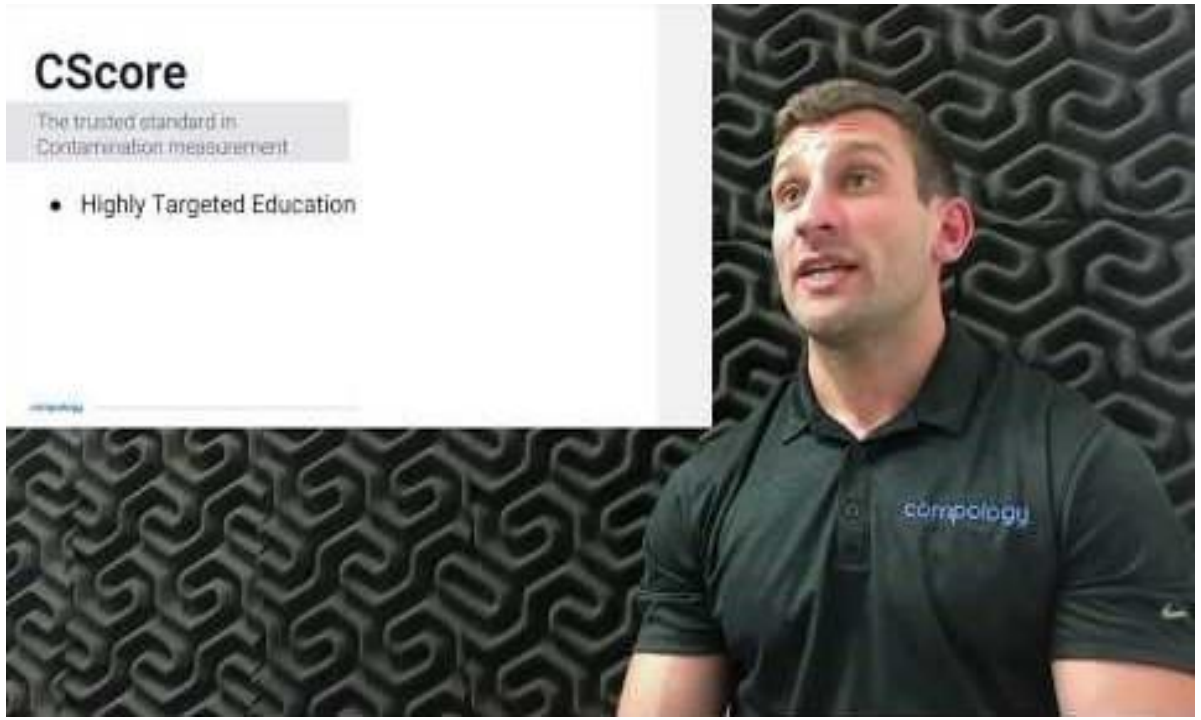
Short List Recommendations

Technology	Manage / Measure Contamination	Improve Bale / Commodity Quality	Time to Implement	Cost to Implement (Payback Period)
Optimizing Existing Optical Sorters	Can be used remove contamination	Improves sort efficiency	Short	Low; Reprograming or installing new sensor
Scalping Screen	Removes contamination	Improves fibre quality	Short	Medium; New screen
Non-wrapping Screen	Removes	Improves fibre quality	Short	Medium; New screen
Artificial Intelligence and Robotics	Can be used to target contamination	Lowers contamination	Medium	High; New sensor and equipment

Long List of Technologies

Collection Bins & Systems	Collection Vehicles	MRF Equipment	Miscellaneous
• In-Bin Remote Sensors and Cameras • RFID Equipped Trucks and Bins • Bin Spring Closures • In-Ground Collection Bins • Underground Collection System	• Front-Load Automated Collection Truck • Alternative Fuels • Electric Powered • Hybrid Solution • Fleet Management – Telematics • Self Sealing Tires • Tire Pressure Monitoring • Self Driving Collection Trucks • Self Driving Transport Trucks • AI Based Cart Recognition	• Black Plastic Optical Sorter • Optimizing Existing Optical Sorters • Fully Automated MRF • Scalping Screen • Non-wrapping Screen • Artificial Intelligence and Robotics • Optibag Program • SCADA (Supervisory Control And Data Acquisition) • Auger Screen • UniSort 5.0 by Steinert • Michelin Tweel Airless Radial Tire • Automatic Switching Power Factor Correction • Levelling Devices • Ballistic Separator • Bag Breaker • Paper/Film Extractor • Optical Scale	• Right Material Mix • Standardized Signage • Back-Office System • Solar-Compacting Smart Public Space Bins • Interactive Sorting Systems • AI – Waste & Recycling Sorting • AI – Waste Management – Saskatchewan • GIS & Big Data • Electronics Recycling – ATM

In-Bin Remote Sensors and Camera



Links:
https://compology.com/cscore (video link)
https://compology.com/technology/blt-specs
https://recycle-smart.com/
http://oneplussystems.com

ECOCOMPASS

Description:
Cameras installed within roll-offs, along with AI technology remotely identifies the level of contamination in recycling or organics bins. Recent advancements in technology now offer highly accurate and automated container volume fullness monitoring sensors. The two leading technology choices are ultrasonic (sonar) or image-based sensors. Container cameras remotely monitor fullness, contents and contamination, location and service. Full software management system, collects data and calls for collection when necessary.

Advantages:
- ✓ Reduces contamination and improves inbound quality
- ✓ Reduced unnecessary collections
- ✓ Real time monitoring

Disadvantages:
- ✘ Does not consider human habits to load at last minute
- ✘ Data plans to maintain can be expensive
- ✘ Operational costs can be high
- ✘ Does not identify actual offender

RFID Equipped Trucks and Bins

Description:
Radio-frequency identification (RFID) technology systems track bins, volume and verify service. Electronic sensors fitted to bins are detected by the truck, ensuring only the bins tagged are emptied, if no tag, alarm will alert the driver. System can be used with any size waste containers and materials and any type of collection vehicle. Minimal investment and quick installation.

Links:
https://www.ecomobile.hr/

https://lateralinnovations.com/en/

Advantages:
- ✓ Allows for PAYT model
- ✓ Reduces errors in collection
- ✓ Can identify contamination source

Disadvantages:
- ✘ Needs regular monitoring to be effective
- ✘ Rugged environment for electronic devices

Front-Load Automated Collection Truck

Links:
https://www.thecurottocan.com/curotto-can/

Description:
Front-load automated collection trucks, combines the increased maneuverability and safety of front-loading trucks, with the efficiencies associated with automated side-arm collection. Collectors are able to focus on the road in front of them reducing accidents, and also provides an opportunity to observe if contamination is being placed in bins. Considerable investment required to change current fleet.

Advantages:
- ✓ Faster load time
- ✓ Less cart damage
- ✓ Helps address contamination
- ✓ Increased driver and road safety

Disadvantages:
- ✘ High upfront investment cost
- ✘ Heavier body lowers payload
- ✘ Length of vehicle difficult maneuver in urban setting
- ✘ Subject to litter when dumping in the body
- ✘ Limited to single commodity (no co-collection)

Black Plastic Optical Sorter (not by resin)

Links:
https://waste-management-world.com/a/new-nrt-optical-sorting-system-allows-separation-of-black-plastics-for-recycling
https://steinertglobal.com/waste-recycling/black-plastics/

Description:
National Recovery Technologies (NRT) and STEINERT have both developed optical sorters that are able to separate black plastics from a recycling stream. NRT uses its In-Flight Technology that combines transmissive detection, placing the material between the light source and the detection camera, and reflective detection, much like typical optical sorters where both the light source and detection camera are above the material.

STEINERT developed its Unisort Black system which use Hyper Spectral Imaging (HIS) Technology to separate black, dark and unknown objects typically not detected by NIR systems.

Advantages:
- ✓ Higher value for mixed plastics
- ✓ Reduced manual labour
- ✓ Higher sorting accuracy
- ✓ Lower disposal costs if black plastics could be marketed

Disadvantages:
- ✘ Unable to differentiate black plastic resins
- ✘ Relatively low value in plastic would make payback unlikely

Optimizing Existing Optical Sorters

Links:
http://magazine.recyclingtoday.com/article/february-2020/best-practices-optical-sorter-maintenance.aspx

Description:
Older optical sorters can be updated with a "sensor only" package that includes the newest technology, or if necessary, a complete retrofit. This can be executed at a significantly lower cost compared with replacing the whole unit, including the high-speed acceleration conveyor.

Additionally, older optical sorters can be used as an Optical Scale to measure throughput and quantify materials (see Optical Scale for more information).

Advantages:
- ✓ Update machinery capability at lower cost
- ✓ Improve productivity
- ✓ Minimum investment and fast installation.

Disadvantages:
- ✘ Upgrades may be limited based on current version owned
- ✘ Sensors such as metal sensor, if used, typically need to be upgraded at the same time

Scalping Screen

Links:
http://www.krausemanufacturing.com/wp-content/uploads/2012/01/CP-Scalping-Screen.pdf
https://www.machinexrecycling.com/wp-content/uploads/2019/10/Scalping-Screen_EN_Web.pdf

Description:

Scalping screens are designed to remove small fibre, containers and other fines from the system to improve the marketability of commodities. Typically used to clean-up the fibre in single-stream programs. Scalping screens will play a larger role in a position after the OCC screen in the newer plant designs for Ontario. Existing ONP screens can be re-worked to a scalping screen set up and operated at a ±15° angle.

Advantages:

- ✓ Decreases contamination in fibre commodities
- ✓ Diverts small recyclables from contaminating fibre materials

Disadvantages:

- ✘ Loss of shredded paper to residue or glass
- ✘ Creates a fines stream that requires treatment

Non-wrapping Screen

Links:
https://vdrs.com/non-wrapping-440-screen/

Description:
Specially designed stars do not become loaded with film or other stringy material and do not let the separation capabilities of the screen to be compromised. Reduces downtime, reduces labour to clean screens, increases capture of valuable commodities.

Advantages:
- ✓ Minimizes downtime
- ✓ Fast cleaning
- ✓ Increases capture of valuable commodities
- ✓ Can be utilized as a scalping screen

Disadvantages:
- ✘ May still require a lot of maintenance of rubber disks

Artificial Intelligence and Robotics

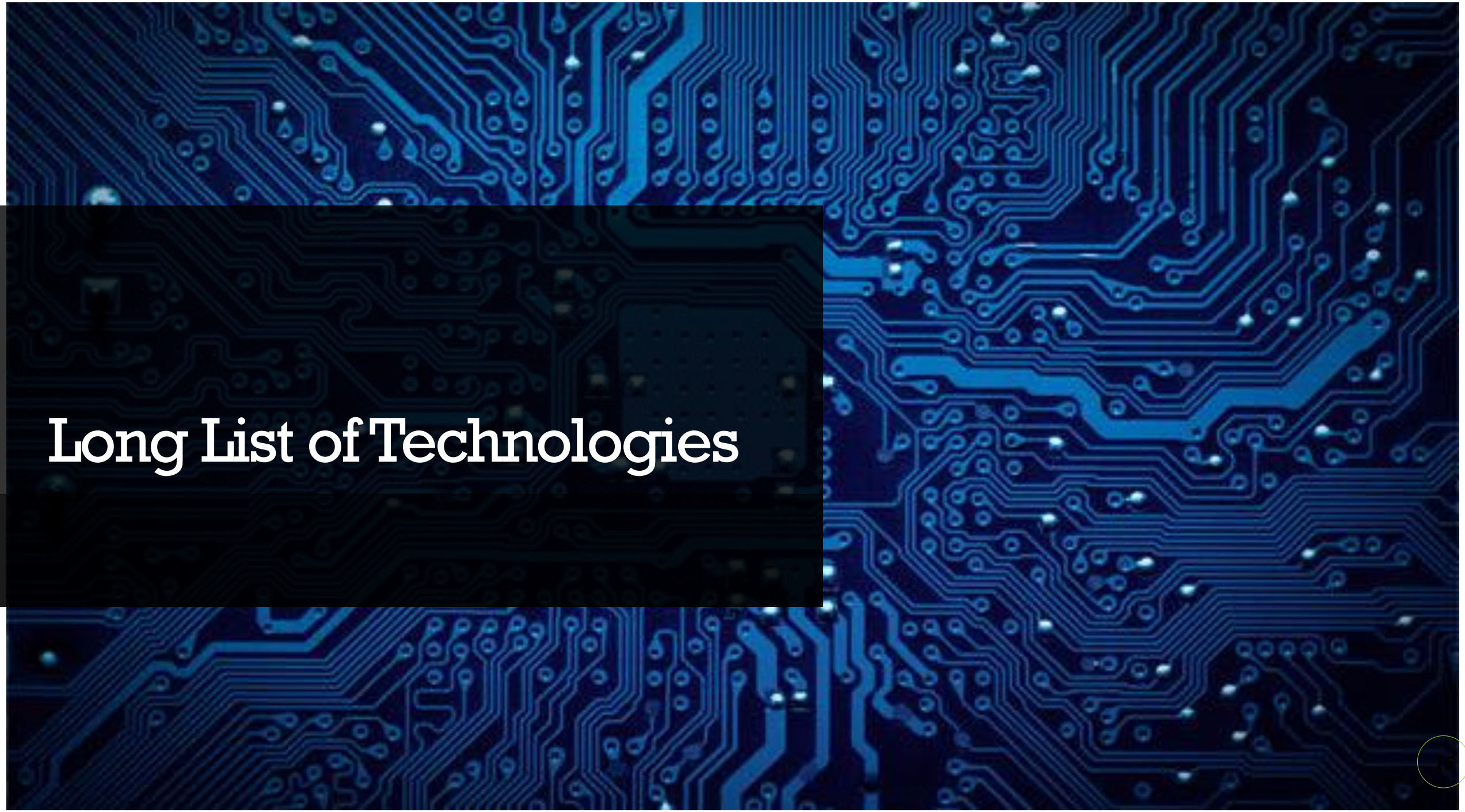
Description:
Use of an overhead robotic arm, camera and artificial intelligence to identify and sort out recyclables, similar to how a manual sorter would. Fully-automated robotic enables for longer run times without breaks, and the ability to reprogram provides greater flexibility and customization.

Links:
https://www.machinexrecycling.com/samurai/ (video link)
https://www.max-ai.com/
https://vdrs.com/single-stream-robotic-sorting-system/
https://zenrobotics.com/

Advantages:
- ✓ Drives operational efficiency and recovery
- ✓ System optimization and maintenance
- ✓ Minimizes downtime
- ✓ Reduced labour costs

Disadvantages:
- ✘ Requires multiple shift operation to justify

Long List of Technologies



List of Technologies

Collection Bins & Systems	Collection Vehicles	MRF Equipment	Miscellaneous
• Bin Spring Closures • In-Ground Collection Bins • Underground Collection System	• Alternative Fuels • Electric Powered • Hybrid Solution • Fleet Management – Telematics • Self Sealing Tires • Tire Pressure Monitoring • Self Driving Collection Trucks • Self Driving Transport Trucks • AI Based Cart Recognition	• Fully Automated MRF • Optibag Program • SCADA (Supervisory Control And Data Acquisition) • Auger Screen • UniSort 5.0 by Steinert • Michelin Tweel Airless Radial Tire • Automatic Switching Power Factor Correction • Levelling Devices • Ballistic Separator • Bag Breaker • Paper/Film Extractor • Optical Scale	• Right Material Mix • Standardized Signage • Back-Office System • Solar-Compacting Smart Public Space Bins • Interactive Sorting Systems • AI – Waste & Recycling Sorting • AI – Waste Management – Saskatchewan • GIS & Big Data • Electronics Recycling – ATM

Collection Bins & Systems

Bin Spring Closures

In-Ground Collection Bins

Underground Collection System

Bin Spring Closures

Links:
https://www.binspring.com/the-product/

Description:
Strong stainless-steel spring fitted to bins to keep the lid closed and reduce damage to bin when emptying. Minimal investment in actual product but would need to supply to all households with instructions or have municipal staff fit the spring.

Advantages:
- ✓ Reduces litter from fallout
- ✓ Stops animals accessing bin contents
- ✓ Reduce moisture contamination
- ✓ Reduces wheelie bin injuries from moving with lid open

Disadvantages:
- ✘ Inconvenient to install after initial launch
- ✘ Makes loading the bin a two-handed operation

In-Ground Collection Bins

Links:
https://www.earthbin.com
https://www.molok.com/
https://www.suterausa.com/

Description:
In-ground collection bins that allow for additional storage of waste and recyclables below ground, while minimizing the bins visible footprint. Bins are ideal for areas with limited space for waste bins such as apartment buildings, and public spaces. Waste is cooled naturally, reducing odour, and secure lid minimizes impacts of wind and pests. Would require some construction and all new streetscape bins. Different vendors have slightly different features; a front load can service an Earthbin, while Molok requires a specialized truck.

Advantages:
- ✓ Reduced collection requirements
- ✓ Minimize litter due to overflow
- ✓ Greater visual appeal of containers
- ✓ Tidier streetscapes

Disadvantages:
- ✘ May require specialized collection truck
- ✘ Issues of bin freezing to the ground

Underground Collection System

Links:
https://www.envacgroup.com/waste-collection-reimagined/envac-in-the-city/

Description:
A pneumatic waste collection system that consists of an underground network of pipes to collect waste to a central point. Space traditionally designated for bin storage is no longer required, and the need for curbside collection trucks or manual handling of waste is minimized. Waste is then picked up from the central location to be delivered for disposal or recycling. The systems can be installed in existing city centres and integrated into the city's architecture.

Advantages:
- ✓ Minimize manual handling of waste
- ✓ Reduces number of collections
- ✓ Reduces transportation costs and emissions

Disadvantages:
- ✘ Unable to handle bulky items such as cardboard
- ✘ High investment cost

Collection Vehicles

Alternative Fuels

Electric Powered

Hybrid Solution

Fleet Management – Telematics

Self Repair Tires

Tire Pressure Monitoring

Self Driving Trucks

AI-Based Cart Recognition

Alternative Fuels

Description:

Alternative fuels are being considered for economic reasons and to lower emissions levels, as regulatory forces head towards zero emission requirements.

Biodiesel is a fuel substitute derived from plants or animals. Biodiesel can be used with no modification to engines.

Compressed Natural Gas (CNG), methane stored at high pressure, can be used in place of regular fuels. CNG combustion produces fewer GHG. Would require fleet change to use CGN.

City of Toronto is looking to capture renewable natural gas (RGN) generated from its landfill sites and anaerobic facilities to fuel their waste collection trucks and/or provide the gas back into the grid.

Advantages:

- ✓ Lower fuel cost
- ✓ Renewable energy
- ✓ Lower GHG emissions
- ✓ Less vehicle maintenance

Disadvantages:

- ✘ High initial cost if fueling infrastructure needed

Links:

https://www.waste360.com/mag/waste_trucks_fueling_diesel
https://www.toronto.ca/services-payments/recycling-organics-garbage/solid-waste-facilities/renewable-natural-gas/

Electric Powered

Links:
Volvo
Lion Electric
Replacing diesel powered refuse trucks with electric

Description:
New fully electric garbage/recycling trucks are being piloted across the world as an opportunity to reduce cost volatility from diesel pricing, as well as reduce emissions.

North American Council of Freight Efficiency (NACFE) concludes that in the long run, electric powertrains will predominate the marketplace due to the efficiency of battery electric powertrains. Large investment to replace fleet of vehicles.

Advantages:
- ✓ Lower fuel costs
- ✓ Lower maintenance costs
- ✓ Lighter body offers greater payload
- ✓ Lower emissions, can operate in low pollution zones

Disadvantages:
- ✘ High upfront investment cost
- ✘ Technology still in early stages

Hybrid Solution

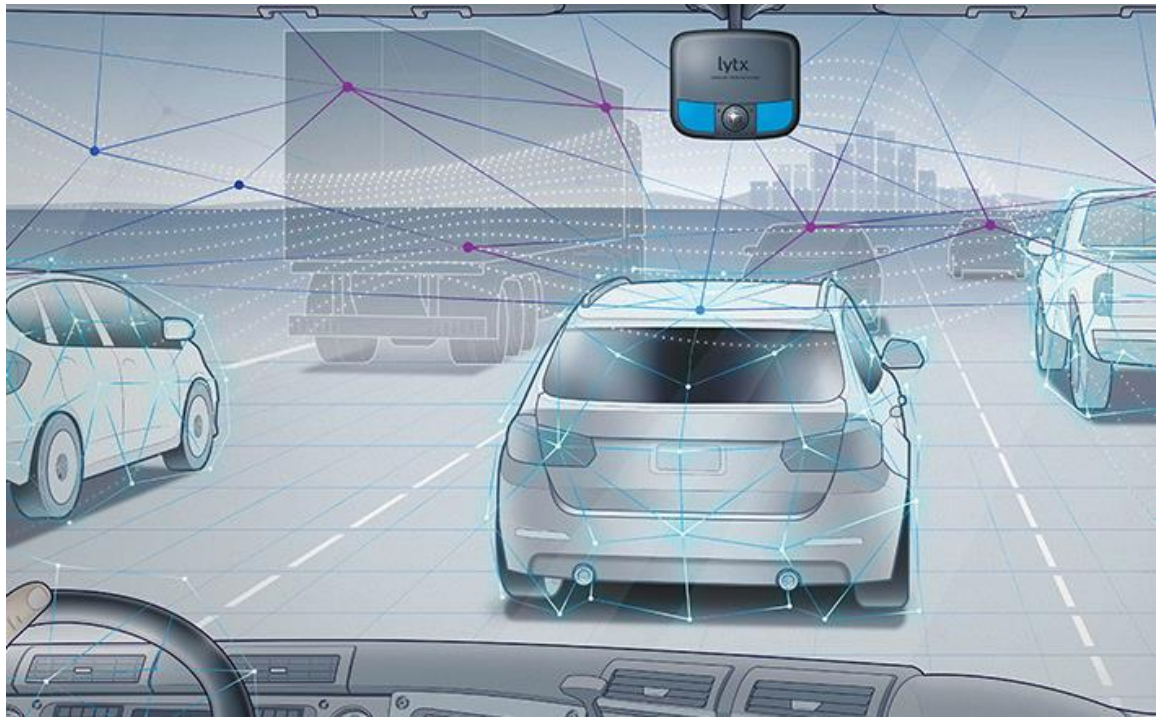
Links:
Effenco

Description:
Effenco's Active Stop-Start™ technology is an electric system designed to shut down the engine of vocational trucks when they are stationary and to provide electric power to the vehicle equipment, cab and chassis accessories including the HVAC system. Since these vehicles spend a large proportion of their operating time immobile, the Active Stop-Start™ technology creates value by reducing engine operating hours and corresponding fuel consumption, emissions and maintenance.

Advantages:
- ✓ Reduces engine hours
- ✓ Lower fuel costs
- ✓ Lower maintenance costs
- ✓ Lower emissions, can operate in low pollution zones

Disadvantages:
- ✘ High upfront investment cost
- ✘ Heavier body lowers payload

Fleet Management - Telematics



Links:
https://www.lytx.com/en-us/

Description:
Telematics, a combination of telecommunications and vehicle technologies, uses cameras, GPS and AI technologies to improve truck routing, increase safety (loading and driving), and identify potential everyday risks. Software and video also can provide evidence to customers and companies in case of accidents or training purposes. Cloud-connected cameras provide up to 100 hours of reliable, continually recorded video evidence along with GPS fleet tracking and integrated video. Could be added to current fleet of vehicles at minimum investment.

Advantages:
- ✓ Data collected improves operations
- ✓ Monitor and maintain vehicles
- ✓ Increase driver and operator safety

Disadvantages:
- ✘ Challenges privacy laws
- ✘ Can add considerable operating costs

Self-Sealing Tires

Links:

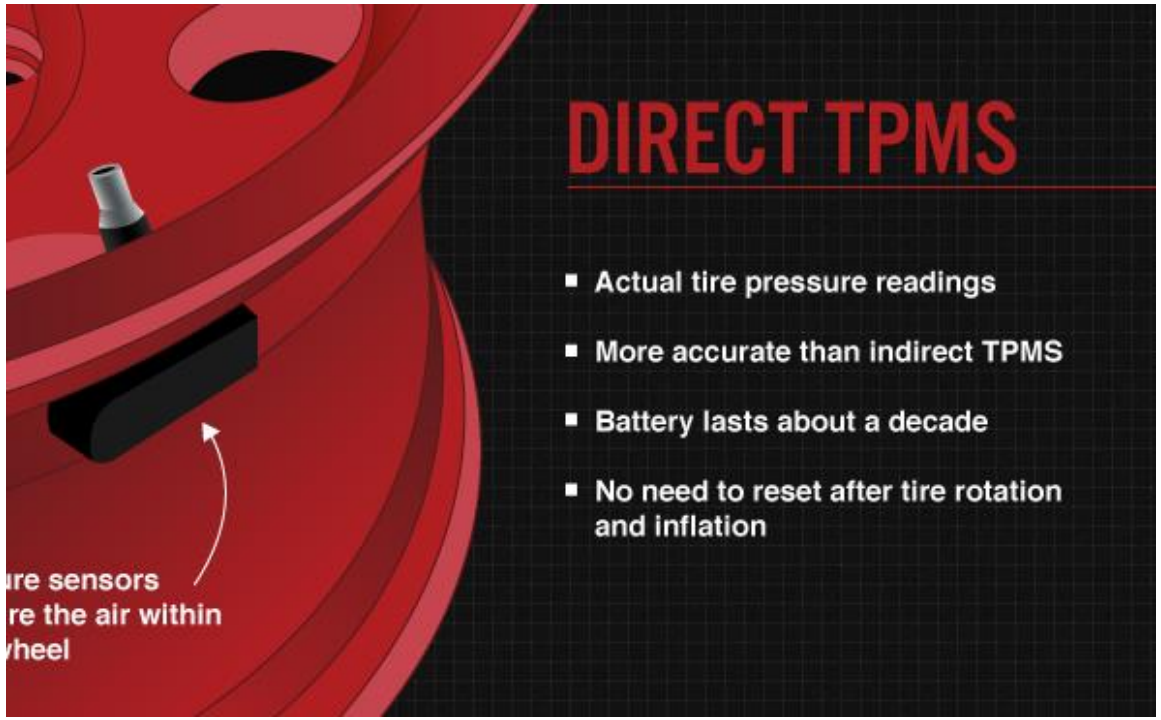
https://www.tireamerica.com/resource/self-sealing-tires

Description:
Self-sealing tires are designed with a sealant built directly into the tire. When a nail puncture occurs, a compound surrounds the nail and quickly seals up to 1⁄4-inch diameter tread punctures. Tires can usually be retreaded multiple times to help extend their use. Initial cost to replace fleet with new tires or consider gradually replacing as needed.

Advantages:
- ✓ Minimizes downtime
- ✓ Can increase safety as no need to pullover to replace tires
- ✓ Reduce cost of tire repair

Disadvantages:
- ✘ Higher upfront cost
- ✘ Does not prevent sidewall perforations

Tire Pressure Monitoring



Links:
https://www.bridgestonetire.com/tread-and-trend/drivers-ed/tire-pressure-monitoring-system-how-tpms-works

Description:
Tire Pressure Monitoring Systems use a tire-pressure sensor, which is a small programmable electronic device, located in the pressurized pocket made by a wheel and tire, that constantly measures the air pressure inside the tire. The sensor transmits that information to the vehicle's onboard computer, and illuminates an amber warning light to alert the driver if one or more tires are low on air. Minimum investment and easy to install in the current fleet.

Advantages:
- ✓ Maintains optimal inflation
- ✓ Improves vehicle safety and handling
- ✓ Improves fuel efficiency
- ✓ Reduces treadwear
- ✓ Reduces CO_2 emissions

Disadvantages:
- ✘ Makes tire replacement more difficult
- ✘ Can reduces effectiveness of circle check inspection

Self-Driving Collection Trucks

Links:
https://www.volvogroup.com/en-en/news/2017/may/news-2561936.html

Description:
Volvo Group, and Renova, a Swedish waste management company, piloted the first self-driving (autonomous) collection truck in 2017. The autonomous truck was designed to allow a collector to focus on emptying the containers while the truck self-navigated from bin to bin.

Advantages:
- ✓ Reduces occupational injuries
- ✓ Consistent vehicle operation reduces fuel consumption

Disadvantages:
- ✘ Still requires a driver
- ✘ Technology still in early stages
- ✘ Too slow to be effective
- ✘ Not commercially available

Self-Driving Transport Trucks

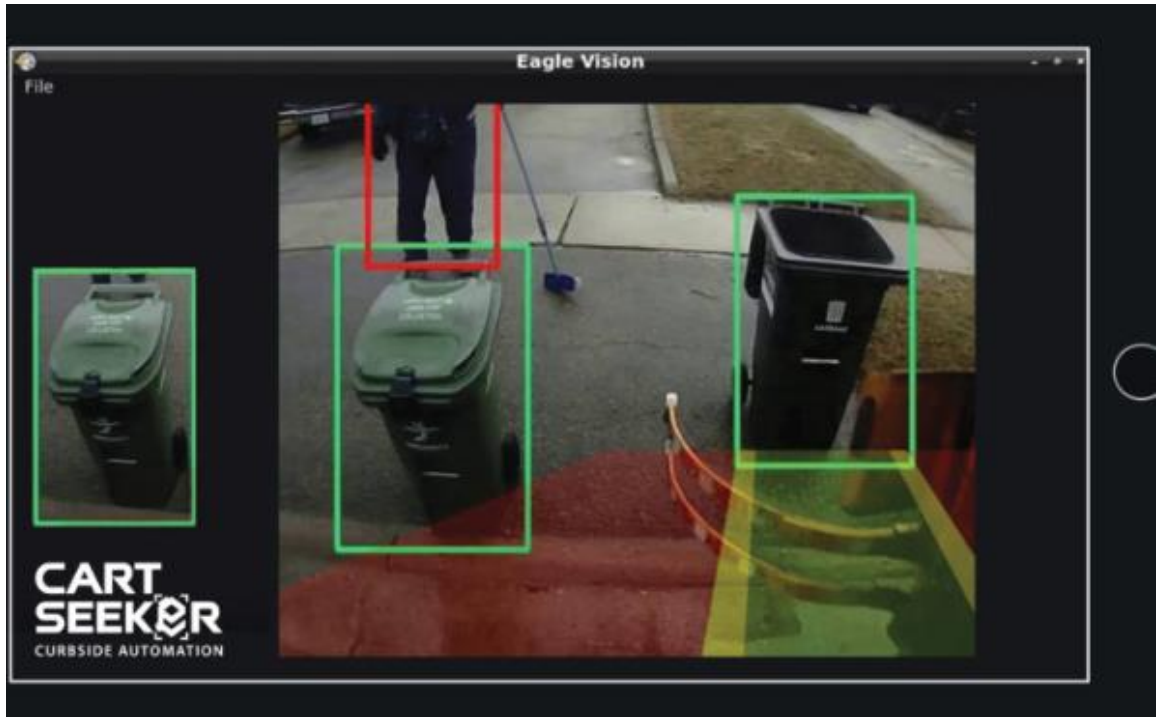
Links:
https://www.atbs.com/knowledge-hub/trucking-blog/self-driving-trucks-are-truck-drivers-out-of-a-jo

Description:
Several automotive companies are exploring self-driving transport trucks to reduce costs, address dwindling truck driver numbers and increase road safety. Daimler, Tesla, TuSimple, Waymo, and Embark are a few companies testing these technologies. Self-Driving transport trucks can become a new norm for municipalities reliant on transfer operations. Technology is still in development

Advantages:
- ✓ Reduces occupational injuries
- ✓ Consistent vehicle operation reduces fuel consumption

Disadvantages:
- ✘ Not commercially available yet
- ✘ Will require special permitting from MTO

AI-Based Cart Recognition



Links:
http://eaglevisionsystems.com/

Description:
AI-based cart recognition technology identifies and locates curbside waste carts and fully automates the operation of the truck's robotic lift arm. The operator simply starts system and stops the truck in front of the cart. The system then automatically picks-up the cart, dumps it, and places the cart back on the ground while the operator focuses on the environment around them. Simple to install/retrofit camera and sensors. No RFID or other hardware/markings required on the cart.

Advantages:
- ✓ Improves route times
- ✓ Faster loading
- ✓ Less cart damage
- ✓ Increase road safety
- ✓ Reduce strain injuries

Disadvantages:
- ✘ Added initial investment
- ✘ Camera must have clear view to operate

MRF Equipment

Fully Automated MRF

Optibag Program

SCADA (Supervisory Control And Data Acquisition)

Auger Screen

UniSort 5.0 by Steinert

Michelin Tweel Airless Radial Tire

Automatic Switching Power Factor Correction

Levelling Devices

Ballistic Separator

Bag Breaker

Paper/Film Extractor

Optical Scale

Fully Automated MRF (Mixed Waste)

Links:
https://www.wastetodaymagazine.com/article/romerike-avfallsforedling-roaf-automated-mixed-waste-facility/

Description:
Due to high labour costs and its remote location, the City of Oslo moved to a fully automated mixed waste processing facility. Stadler was successful in winning the contract to provide the equipment for the facility at a cost of $234 million dollar (US); it consists of 145 conveyor, 16 NIR optical sorters, two drum screens, one vibrating screen, a star screen, a shredder, two bag openers, two ballistic separators and an eddy current. It can process 40 tonnes per hour. Major investment required to fully automate a current MRF.

Advantages:
- ✓ Removes reliance on manual sorters
- ✓ Increases purity of feedstock
- ✓ Reduce labour costs

Disadvantages:
- ✘ Significant capital cost requirement

Optibag Program

Links:
https://optibag.nu/en/optical-sorting/

Description:
Fully automated optical sorting system, separates different coloured bags containing waste/recyclables, that have been source sorted. Residents are required to place their waste/recyclables into the corresponding coloured bag (i.e. organics in green bag, containers in blue bag, etc.) and then place it into a single bin. Provides the benefits of single-stream collection, while having clearly identified bags to allow for optical sorters to identify the stream the material belongs to. Major investment into new machinery. Would need to educate and supply bags to households/businesses. Existing waste collection trucks can be retained and not replaced.

Advantages:
- ✓ Single stream collection
- ✓ Reduced contamination
- ✓ Reduced number of collections
- ✓ Reduced manual labour sorting

Disadvantages:
- ✘ Requires bag singulation limiting scale of facility

SCADA (Supervisory Control And Data Acquisition)

Links:
https://www.machinexrecycling.com/products/automation-control-supervisory/

Description:
System to monitor all equipment in MRF. Check machine operating efficiencies, downtime etc., reports in real-time to detect productivity losses and thus improve profitability. The system provides flexible control for the maintenance and operating crew, as well as powerful management tools for the plant supervisor. Medium investment to equip MRF with new control system.

Advantages:
- ✓ Reduce equipment downtime
- ✓ Increase productivity
- ✓ Enables operators to remotely manage equipment

Disadvantages:
- ✘ Still requires visual maintenance check
- ✘ Works best with equipment wired for communication

Auger Screen

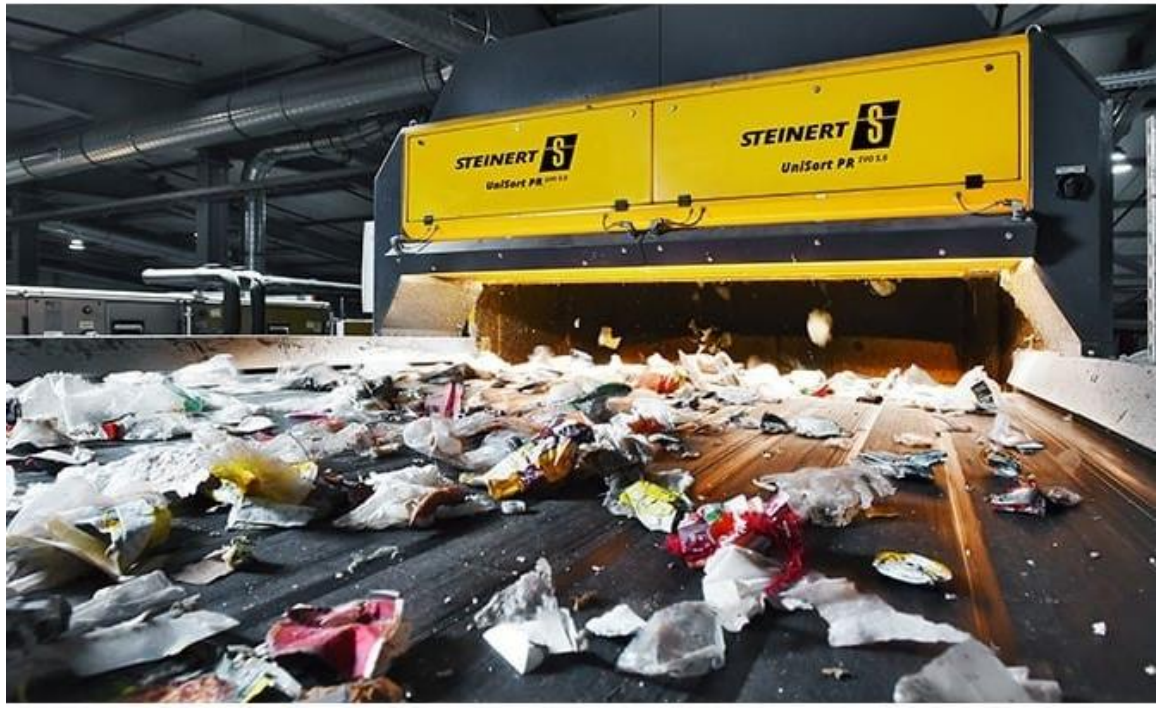
Links:
http://www.cpgrp.com/wp-content/uploads/2019/03/CP-Auger-Screen-LR.pdf

Description:
Auger Screen sizes material by using a series of cantilevered augers that do not wrap or jam, requiring very low-maintenance. Maintains reliable sizing at high volumes for Single Stream, C&I, C&D, and MSW applications. Decreases amount of material seen by sorters, increases efficiency. Minimal investment, fast installation.

Advantages:
- ✓ Reduces manual labour
- ✓ Lower maintenance costs
- ✓ Efficient sorting

Disadvantages:
- ✘ Possible safety hazard
- ✘ Unproven concept
- ✘ Reliability unknown

UniSort 5.0 by Steinert



Links:
https://www.recyclingtoday.com/article/steinert-unisort-evo5-recycling-sorting/

Description:
AI-supported object detection system for sorting machines. Dynamic calibration monitors the spectrum of the belt lighting, optimized valve blocks delivers a consistently precise separation of flowing materials. Light boxes designed to ensure improved detection while also simplifying maintenance, combined with software updates. AI learning coupled with improved sensors allows for improved detection on chemical composition; for example, PET bottle can be separated from a PET tray or PET multi-layer.

Advantages:
- ✓ More accurate automated separation
- ✓ Reduces need/cost for manual separation
- ✓ Further separation of existing recyclable commodities.

Michelin Tweel Airless Radial Tire

Links:
https://www.michelintweel.com/

Description:
Airless radial tire, one single unit, replacing current tire and wheel assembly. Once they are bolted on, there is no air pressure to maintain, and the common problems of unseated beads and flat tires are eliminated. High performance compounds and an efficient contact patch are designed to provide a long wear life that is two to three times that of a pneumatic tire at equal tread depth.

Advantages:
- ✓ No air pressure to maintain
- ✓ No downtime with flat tires
- ✓ Absorbs impacts easier on powertrain
- ✓ More comfortable for the operator

Disadvantages:
- ✘ Higher upfront investment cost

Automatic Switching Power Factor Correction

Links:
https://www.cosphi.com/apfc

Description:
A power factor correction bank (PFC) is a power efficiency device. PFC reduces line-losses and reduces the kVA load between the electric utility and end-user. Comprehensive power monitoring system offers increased knowledge of how energy is used within a facility, identifies areas to improve efficiency, minimize waste, and reduce energy consumption. Also reduces exposure of personnel to potentially hazardous electrical environments. Easily installed into current MRF.

Advantages:
- ✓ Reduces energy cost
- ✓ Improves personnel safety
- ✓ Increase life of generators
- ✓ Low maintenance
- ✓ Pays for itself

Leveling Devices

Links:
https://www.machinexrecycling.com/products/leveling-devices-drum-feeder-back-scraping-drum/

Description:
1 - Drum feeder - ensures a constant supply to the recycling line, absorbs impact during loading, gives retention time to the input material.

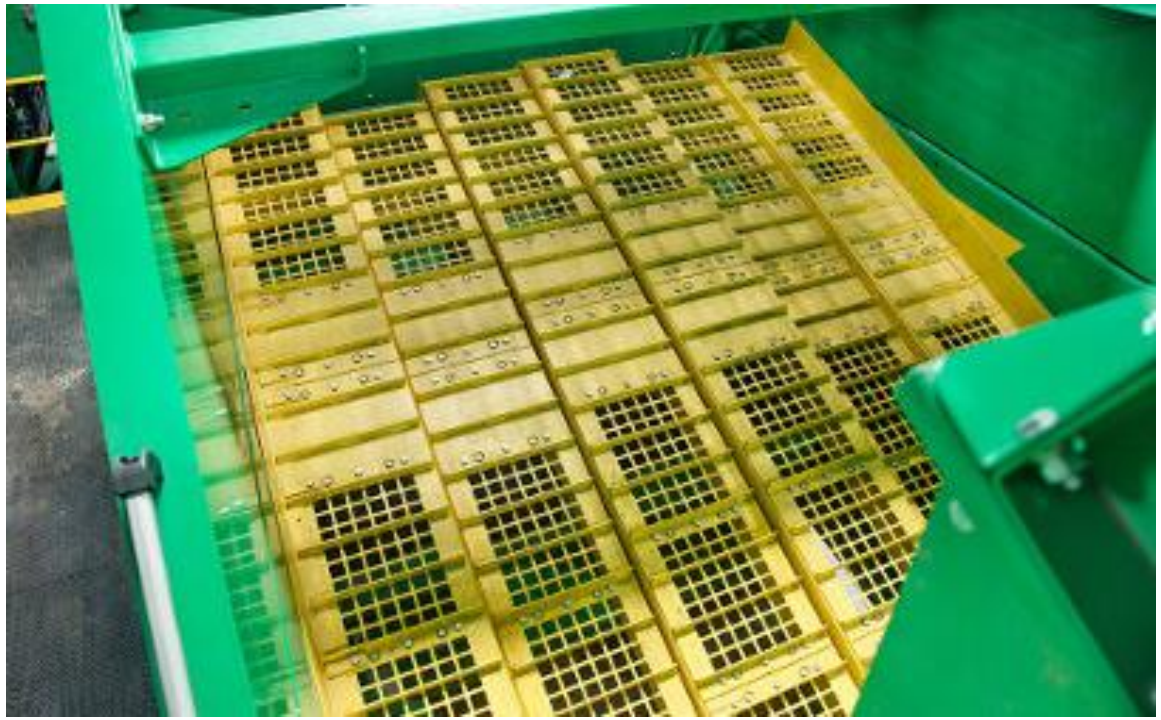
2 - Back scraping drum - ensures a constant height of input material that optimizes sorter operations and the system itself.

Minimum investment, easily installed.

Advantages:
- ✓ Improved sorting efficiency from consistent burden depths
- ✓ Improved loading of materials from tip floor
- ✓ Can open bags if equipped with “teeth”; beneficial in bag based programs

Disadvantages:
- ✘ Commercial OCC can affect performance
- ✘ If equipped with “teeth”, it may open bagged film and/or bagged garbage

Ballistic Separator



Links:
https://komptechamericas.com/product/ballistor-waste-separator/
https://vdrs.com/lubo-usa-llc/

Description:
Ballistic separators are used to separate 2D, 3D and fine fractions, typically used in single-stream MRFs. Striding paddles walk 2-dimensional objects over the screen (items like film bags and light sheet paper). Rigid items (bottles, cans, 3-D cardboard) bounce back. Paddles have true 2-inch holes in them to allow the last bit of glass fines to fall through.

Advantages:
- ✓ Minimal maintenance cost
- ✓ No star changes required
- ✓ Reduced contamination

Disadvantages:
- ✘ Limited throughput unless multiple separators installed
- ✘ Their size makes it hard to insert in a retrofit

Bag Breaker

Links:
https://www.bulkhandlingsystems.com/equipment/bag-breaker/

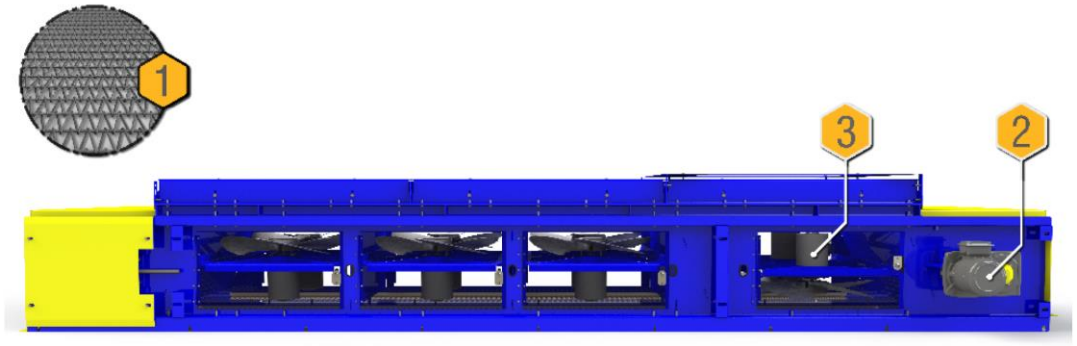
http://www.cpmfg.com/recycling-equipment/recycling-sorting-equipment/bag-opener/

Description:
Bag Breaker rips open bags without damaging recyclables. This enables municipalities to allow residents to place recyclables (or excess recyclables) into bags without having to provide carts or bins. The system uses large, counter-rotating drums or knives to efficiently open the bags and release the contents, discharging them from the bottom of the machine. Bags are torn into large pieces for easy removal.

Advantages:
- ✓ Allows for increased collection
- ✓ Eliminates manual tearing of bags

Disadvantages:
- ✘ Unfilled bags get missed
- ✘ Less effective at removing smaller bags (grocery size)
- ✘ Can be difficult to recover film pieces
- ✘ Doesn't separate contents from bag; just rips them

Paper/Film Extractor



CONSTRUCTION & FEATURES (REFER TO 3D DRAWING)

1. Belt: steel mesh
2. Adjustable gate for a good separation of heavy and light fraction
3. Fan motor: ¼ HP

- Fan speed control: potentiometer on each fan
- Adjustable height: travel screw mounted
- Mesh belt motor: 2 HP TEFC direct drive

Links:
https://www.machinexrecycling.com/wp-content/uploads/2017/05/Paper-film-extractor_sheet.pdf
https://www.bollegraaf.com/technologies/shredders/bollegraaf-filmgrabber-2

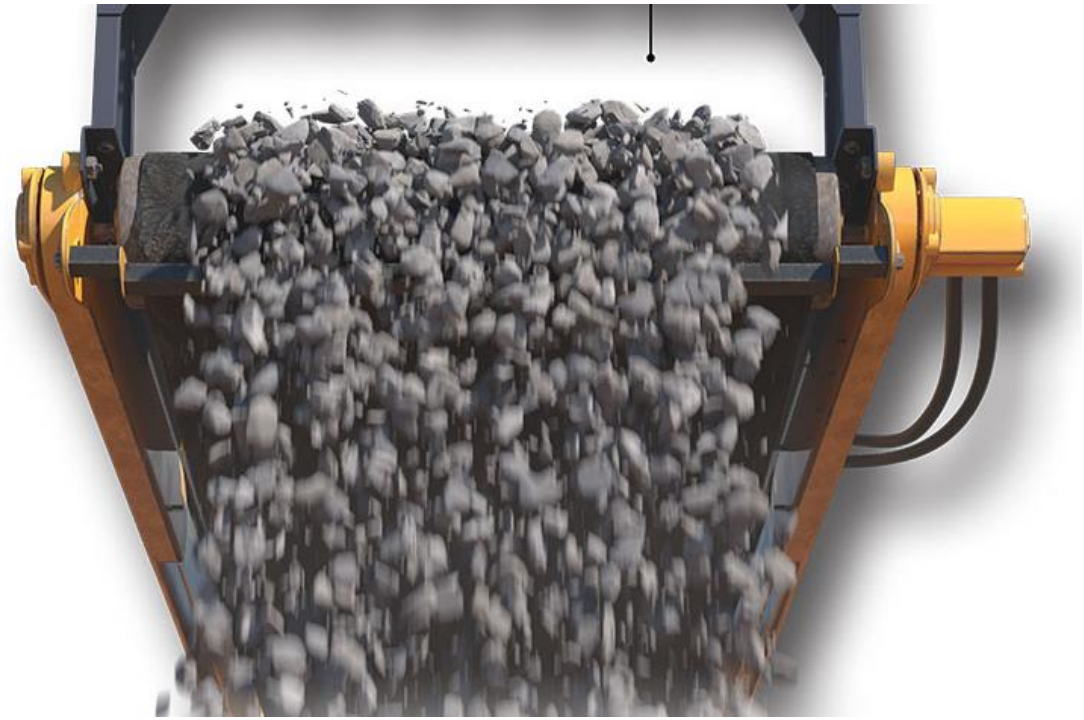
Description:
Two types of systems:

1. Machinex System consists of a mesh belt and is equipped with fans in its interior portion which are designed to pick and remove undesired paper and film from a material stream like a container line. Ideal for removing film and paper from larger materials that will be sorted down stream.
2. Bollegraaf system consists of a revolving drum with a variable speed motor and inward and outward moving pins. The recyclables are moved up by air, which allows the films and foils to be picked up by the pins inside the revolving drum.

Advantages:
- ✓ Removes film and paper from a heavier stream (containers)
- ✓ Versatile equipment that can be installed in line or cross-belt, on a new or existing system

Disadvantages:
- ✘ Collects dust with film reducing film quality
- ✘ Will also collect unwanted lights like flags

Optical Scale



Links:
http://www.opticalbeltscale.com/

Description:
Contact free volumetric scanner, using the latest laser technology, effectively scans the material crossing the belt with a measurement accuracy of 1mm variance. Accurately measures the volume and weight, which can be useful to measure the impact of lightweighting of materials on MRF operations.

Advantages:
- ✓ Realtime, accurate data.
- ✓ Allows for tracking of volume over weight only

Disadvantages:
- ✘ It measures volume regardless of density or contents
- ✘ Can be affected by cleats

Miscellaneous

Right Material Mix

Standardized Signage

Back-Office System

Solar-Compacting Smart Public Space Bins

Interactive Sorting Systems

AI – Waste & Recycling Sorting

AI – Waste Management – Saskatchewan

GIS & Big Data

Electronics Recycling – ATM

Right Material Mix

Links:
https://resource-recycling.com/recycling/2020/02/11/isri-to-consider-residential-recyclables-specs/

Description:
New ISRI guidelines defining two important municipal recycling terms, “Inbound residential single stream” and “inbound residential dual stream.” The purpose is to give MRFs and municipalities “a common vernacular to negotiate the items that comprise the material stream” in single-stream and dual-stream collection programs.

Advantages:
- ✓ Improved communication between municipalities
- ✓ Easier to define for end user
- ✓ Facilitates the processing of marketable commodities

Disadvantages:
- ✘ Requires most programs to roll back acceptables
- ✘ Perceived as preventing innovation

Standardized Signage

Links:
https://www.recycleacrossamerica.org/

Description:
Movement to standardize labels on recycling bins. Standardized labels on bins help people recycle more effectively and reduce contamination and reduce "wish-cycling". It provides for consistent language, colour, artwork and images to define one common program.

Advantages:
- ✓ Consistent messaging on recycling, waste, and organics
- ✓ Improves diversion and reduces contamination

Disadvantages:
- ✘ Difficult to get everyone to agree on the standard
- ✘ MOE has promised no changes through transition

Back-Office System

Description:
Complete back-office management system including account management, billing, analytics and reporting, operations management, and security data management. Medium investment in software, easily integrated.

Links:
http://trux.com/haul-it-waste-management-software-application-route-software/

Advantages:
- ✓ Accurate data reports in real time
- ✓ Enables billing for actual services rendered
- ✓ Tracks customers, containers, drivers, trucks, and services in a logical easy to understand format.

Disadvantages:
- ✘ Limited opportunities to connect with third party devices

Solar-Compacting Smart Public Space Bins

Links:
https://www.ecubelabs.com/solar-powered-trash-compactor/
https://bigbelly.com/

Description:
Compacting bins can hold substantially more than non-compacting bins. Equipped with sensors that can send and receive real time data. Reduces need for collections and stops animals from emptying bins. Major investment required to replace public space bins.

Advantages:
- ✓ Reduces operating costs from solar power
- ✓ Reduces haulage costs by optimizing collections
- ✓ Reduces litter, no overflowing bins

Disadvantages:
- ✘ Can result in heavy collections for people servicing the bins increasing risk of injuries
- ✘ May require heavier gauge bags to handle pressure

Interactive Sorting Systems

Links:
http://evoeco.com/index.html

Description:
Digital video captures attention and shows users the exact items in your waste stream. On-screen messages educate and motivate users every time they throw away their waste in the bins. When a user discards their waste, sensors inside the EvoBin trigger responsive messages. Messages can be customized for specific audiences and events. Medium investment for video screens and software, for installation in public places.

Advantages:
- ✓ Improves sorting accuracy
- ✓ Reduces contamination
- ✓ Creates reports from data collected

Disadvantages:
- ✘ Investment exceeds value of materials
- ✘ Requires power outlet in public space

AI – Waste & Recycling Sorting

Links:
http://bine.world/howitworks/

Description:
Single bin uses AI to recognize items and sorts them into correct internal capture bins. Bin-e optimizes waste management in your facility, allowing you to save costs, time and labour. It ensures precisely sorted raw material through automatic recognition and segregation. The compression of plastic and paper reduces the frequency of emptying the bins. Medium investment to purchase and install new bins.

Advantages:
- ✓ Reduces contamination
- ✓ Fill levels in real time
- ✓ Increases recycling though ease
- ✓ Data in real time

Disadvantages:
- ✘ Expensive public space bin
- ✘ Requires power outlet in public space
- ✘ Requires a collection vehicle with multiple compartments

AI – Waste Management – Saskatchewan

Links:
https://www.yorktonthisweek.com/regional-news/artificial-intelligence-used-to-track-sask-waste-1.24073716

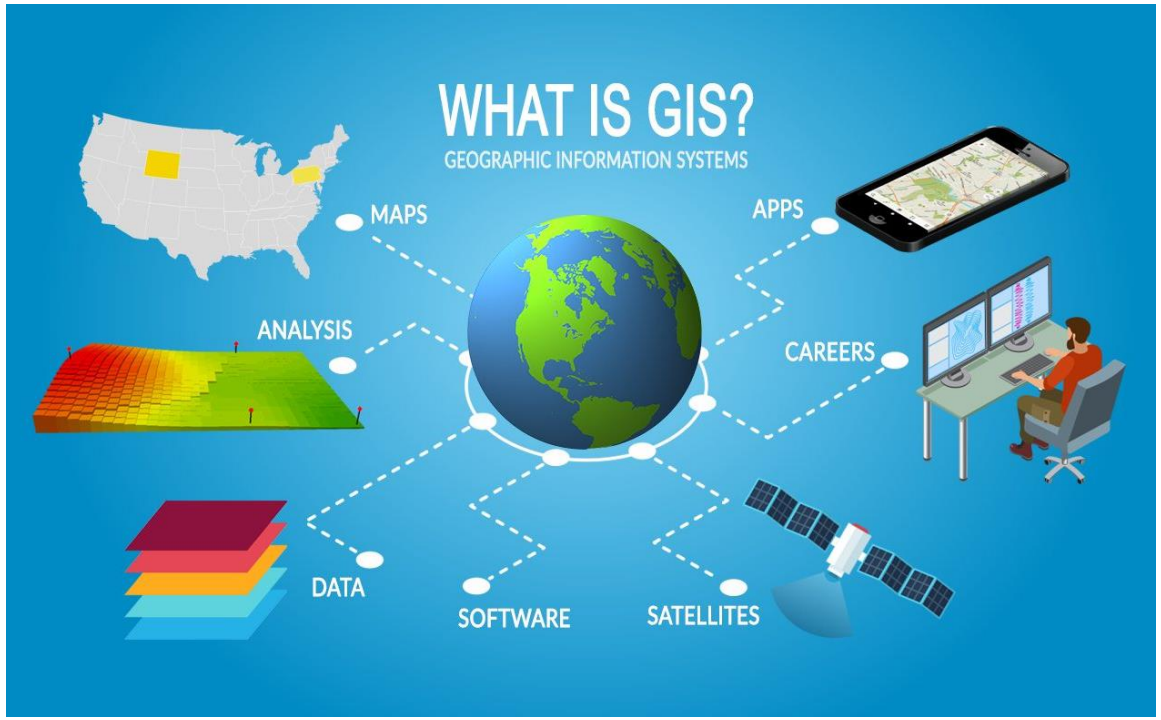
Description:
In 2019, Prairie Robotics was awarded $10,000 to develop their system of integrated artificial intelligence and cameras to capture waste data in real time and automatically generate reports from across the province.

Researchers at the University of Regina created a system, optimized for Saskatchewan's extreme weather, to weigh moving vehicles. AI already tested in Canada, could learn from any issues/roadblocks to improve installations in Ontario.

Advantages:
- ✓ Accurate data reports in real time
- ✓ Reduces human error

Disadvantages:
- ✘ Not available commercially yet

GIS & Big Data



Links:
https://www.esri.com/en-us/what-is-gis/overview

Description:
A geographic information system (GIS) is a framework for gathering, managing, and analyzing data. Using big data analysis and GIS to identify the efficiency of waste management and transportation. Rooted in the science of geography, GIS integrates many types of data. It analyzes spatial location and organizes layers of information into visualizations using maps and 3D scenes. With this unique capability, GIS reveals deeper insights into data, such as patterns, relationships, and situations—helping users make smarter decisions. Minimal investment in software, would need to train staff on use.

Advantages:
- ✓ Optimizes collection routes
- ✓ Reduces fuel costs
- ✓ Creates large data sets for better waste management

Disadvantages:
- ✘ Data may not include private roads
- ✘ Certain variables not included in route optimization

Electronics Recycling - ATM

Description:
Vending machine that recycles mobile phones and pays out instantly to the user. Collects phones that might otherwise be thrown in garbage by offering instant cash. Major investment in the ATMs to be located in easy access areas for the public.

Advantages:
- ✓ Increases electronic recycling
- ✓ Automatically clears data, reducing identity theft
- ✓ Ease of use

Links:
https://www.ecoatm.com/

Thank You

ECOCOMPASS

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