Digital technologies in kerbside collections

May 2026

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Introduction

- Zero Waste Scotland commissioned a review of existing evidence relating to digital technologies used in kerbside collections.
- To support Scottish local authorities better understand the technologies available and potential benefits/challenges.
- To support:

Modernising recycling and waste services

A priority in Scotland's Circular Economy Route Map to 2030

Research

- Two main parts:

Literature review

Webinar with Local Authorities
February 2026

Learnings from the literature review

- Limited formal information on how technology is currently used.
- Initial google search terms were widened and Co-pilot was used.
- Much of the information gathered is from technology providers and not independently verified.
- Some useful case studies found, but detailed reports about the benefits and costs are limited.

Eight technology types: 3 Categories

Routes design & optimisation

In-cab mobile technology

Widely used

Smart bin sensors

Unique bin identifiers

Bin weighing

Growing interest

AI materials identification

AI bin identification

AI waste composition analysis

Emerging

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Growing Interest Technologies

Smart bin sensors

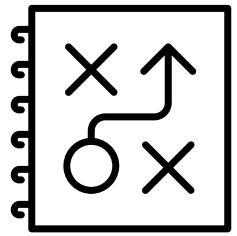
- Aim to empty bins only when required i.e. when close to being full.
- Previous trials common (IOT) with limited examples of success.
- More suited to larger communal or commercial bins and remote bins.

Several technology providers found:

Brighter Bins	Sensneo	Ecube Labs	Rayven
Waste Solutions	IoTech	Contel Ltd	Bigbelly Waste management
Heliot Europe			

Smart Bin Challenges

- Certain materials more suited e.g. glass.
- Rugged and reliable sensors are required.
- Signal access in remote areas.
- Ongoing maintenance, support, licensing.
- Unintended consequences? Bins get emptied more frequently if filling up quickly.



Growing Interest Technologies

Unique Bin IDs

Ability to track bin e.g. contamination etc to household

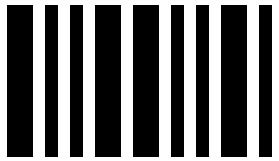
- Radio Frequency Identification (RFID) tags/chips.
- Becoming standard for suppliers to offer RFID tags with new bins.
- Costs uncertain but < £1 per bin make future proofing viable.

Several technology providers found:

AMCS	Sensneo	HID Global	Toter
Winnix Technologies	Bin.Chips	Deister	STARNFC
Global Tag			

Bin ID Challenges

- Retrofitting to bins already in use is complex & expensive.
- Vehicle mounted readers, software integration/maintenance requires resources.
- Privacy & data concerns when individual household related data is captured and stored.
- Operational complexity for crews e.g. ensuring readers are working.
- Sustainability challenges. Plastics/metals/electronics (e-waste).



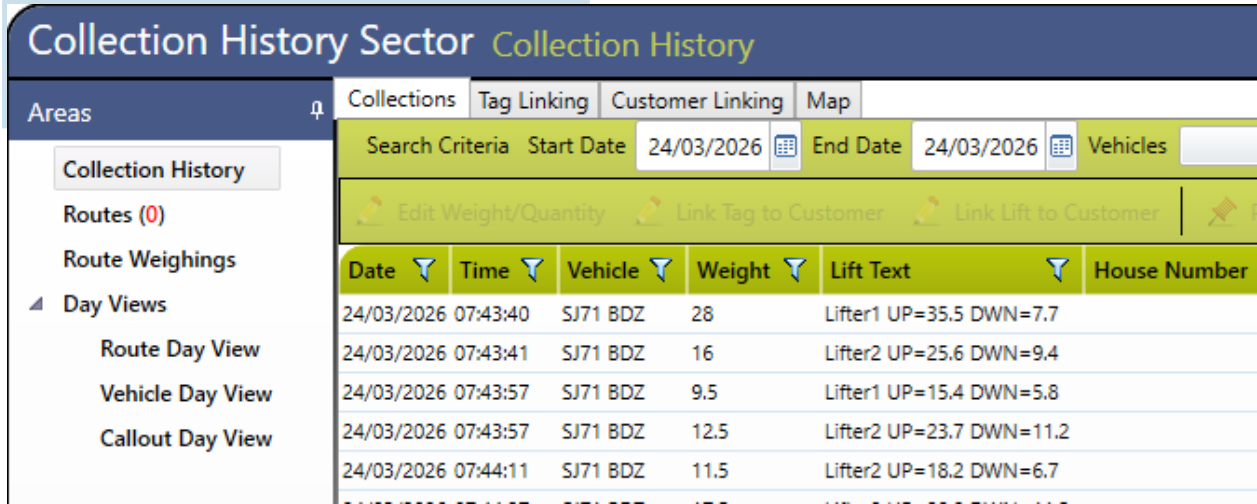
Growing Interest Technologies

Bin weighing

Ability to obtain weights from single bin lifts

- Increased understanding of recycling behaviours.
- If combined with RFID, household arisings can be measured across all streams.
- PAYT when used with RFID already used in other countries e.g. Ireland.

AMCS	Air-Weigh	VWS Enviroweigh	WIS
Weightron Bilanciai	MOBA Mobile Automation UK	Qlar bin weighing system kits	

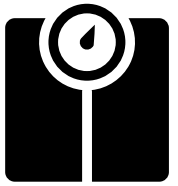


Bin Weighing Challenges

- Integration with existing working e.g. Lifter speeds.

  A major issue with crews.

- Equipment requires regular calibration/verification.
- Operator behaviour may have to be adjusted e.g. grabbing bin.
- Volume of data and access for analysis must be considered e.g. who hosts data and has access to it?



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Emerging Technologies

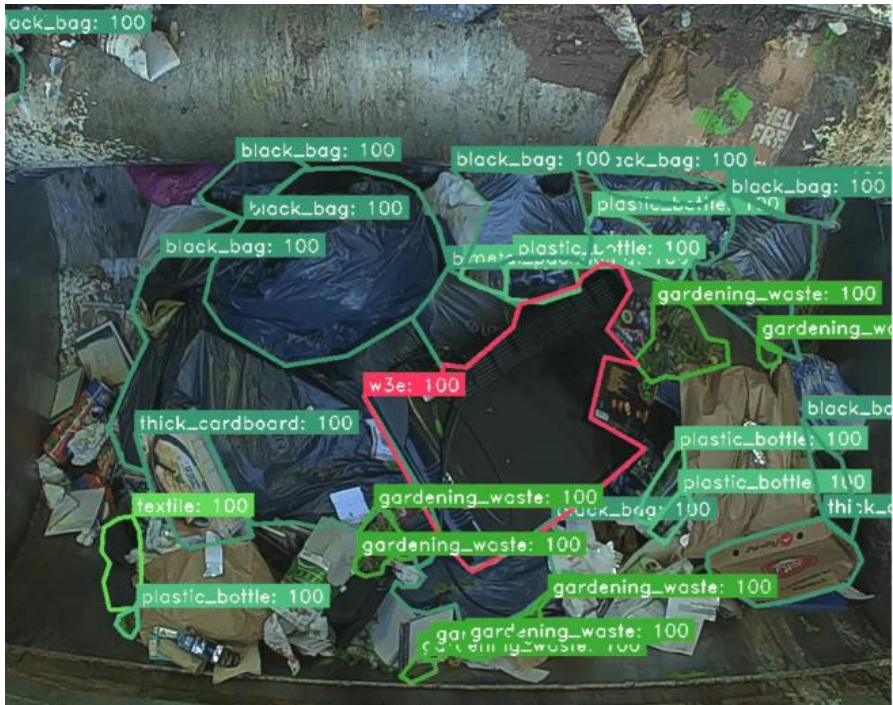
AI Materials Identification

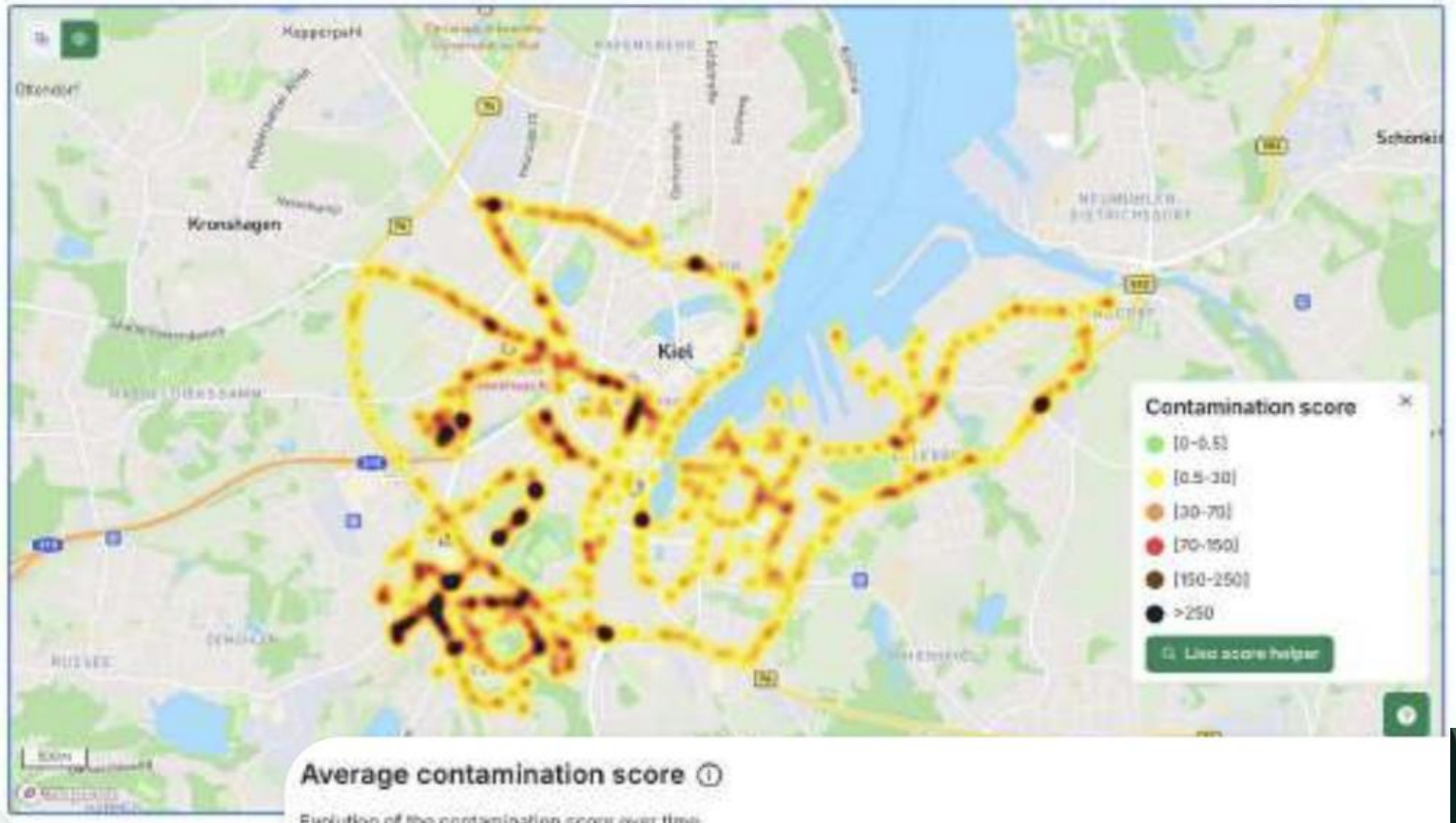
Computer vision and machine learning to identify items

- Cameras installed on RCVs to identify materials in hopper.
- Detailed mapping can be built up showing contamination types and histories (route/street/household).
- Hazardous items detected and driver/crew notified in near real time.

Several technology providers found:

Lixo	AMCS Vision AI	Third Eye Data
Evreka	Phoenix AI	WasteVision AI





- Customizable scores/displays to align with priority materials
- Cumulative over repeated collection cycles
- Inform focused and varied interventions

Municipality type	No of Residents	No of waste streams	% change in contamination score (%)	Potential annual savings (€)
Rural	19,000	2	-45	59,000
Rural + Urban	98,000	3	-20	306,000
Urban	806,000	3	-54	2,500,000

Caveats

- Small numbers targeted in highest contamination areas then measured improvement scaled up across large areas.
- How are savings calculated?
- Only realised with good communications resources/strategies.

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Contamination alert when a round reaches a level of contamination score

SMS/Email to Ops manager

→ reroute truck or receive it specifically in case of high contamination

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Bin contamination alert triggered upon reaching a defined level of contamination

Lights in the hopper for collection operators

→ inform directly citizen/producer its bin was too contaminated (tag, “cravate”, “cintre”, etc.)

Budget - Proof of value_Pilot

	4 RCVs 12 months
Equipment Provision of equipment for the whole period.	**5 875 € / RCV**
Installation (optional)	*1 000€ / RCV
Subscription Subscription to the platform, user access, maintenance, data transfer and updates for the entire period.	**3 905 € / RCV / year**
Total	**Total Budget: 39 120€**

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AI material Identification Challenges

- Visibility of materials in the RCV hopper. Residual stream is more difficult- variety of materials and plastic bags.
- Equipment required: Cameras, LEDs, cabling, in cab box.

  (4-6 hours RCV transfer).
- Face blurring for privacy, camera angles inwards to avoid outside hopper content.
- Large amounts of data to be stored and analysed. Environmental footprint of such AI technologies in general is an issue.

Emerging Technologies

AI Bins Identification

Computer vision and machine learning to identify bins

- Use of existing RCV data to geolocate and log bin collections.
- Calculate participation rates, pick rates for any bin types/colours.
- User defined polygons (Census areas, Postcodes, Street).
- No active participation or extra equipment required.
- Alternative to expensive manual survey techniques.

Only 3 technology providers found:

Voom AI Clearsight	Premio Inc	Oshkosh Corporation

AI Bin Identification Pilot Study

Argyll and Bute-Mid Argyll Pilot Study (2024)

Bioban- SEPA derogation from Pre-Treatment for Residual to EfW.

Evidence required: *Measure participation rates, identify and*

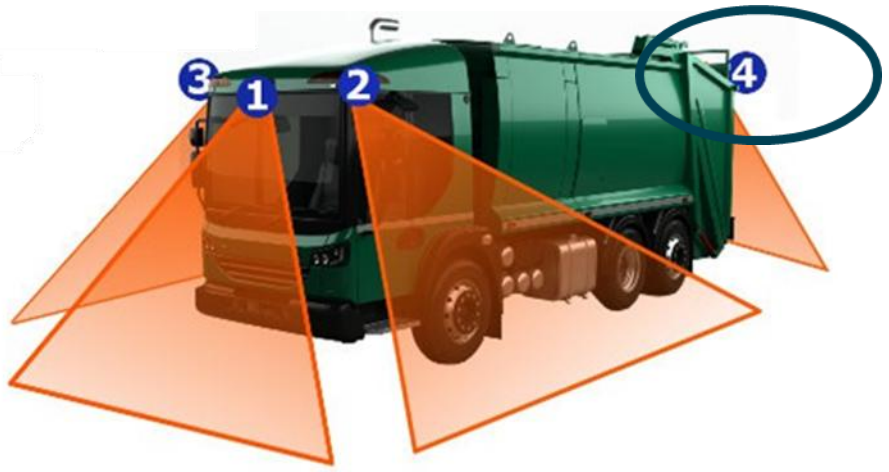
target areas of low participation.

How to measure participation rates:

1-In-Cab (not in place yet and needs active participation by drivers) 2-**Manual survey-** lack of resources and expensive for basic data.

3-**Use AI to leverage existing data?**

AI Bin Identification Pilot Study



CCTV Data

Activity Report () - Vehicles Oriented

Date Range: 28/08/2024 - 13/09/2024 Generated By:

<- Main Summary <- Prev Company: Argyll and Bute Council

Event	Date	Time	Driver	Fleet	Location	Direction	Speed	Latitude	Longitude
Timed Update	28/08/2024	07:35:16		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	E	0	56.08561667	-5.541838889
Timed Update	28/08/2024						0	56.08561667	-5.541838889
Timed Update	28/08/2024						0	56.08561667	-5.541838889
Timed Update	28/08/2024						0	56.08561667	-5.541838889
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Timed Update	28/08/2024						0	56.08561667	-5.541838889
Timed Update	28/08/2024						0	56.08566111	-5.541277778
Timed Update	28/08/2024	07:37:02		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	NE	16	56.08598611	-5.540141667
Timed Update	28/08/2024	07:37:17		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	E	17	56.085825	-5.538211111
Timed Update	28/08/2024	07:37:32		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	NE	26	56.08674722	-5.536363889
Timed Update	28/08/2024	07:37:47		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	NE	28	56.08792222	-5.53455
Timed Update	28/08/2024	07:38:03		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	NE	30	56.08950278	-5.532380556
Timed Update	28/08/2024	07:38:18		Waste Collection	Crinan, Argyll and Bute, PA31 8QJ	NE	33	56.09100278	-5.530308333

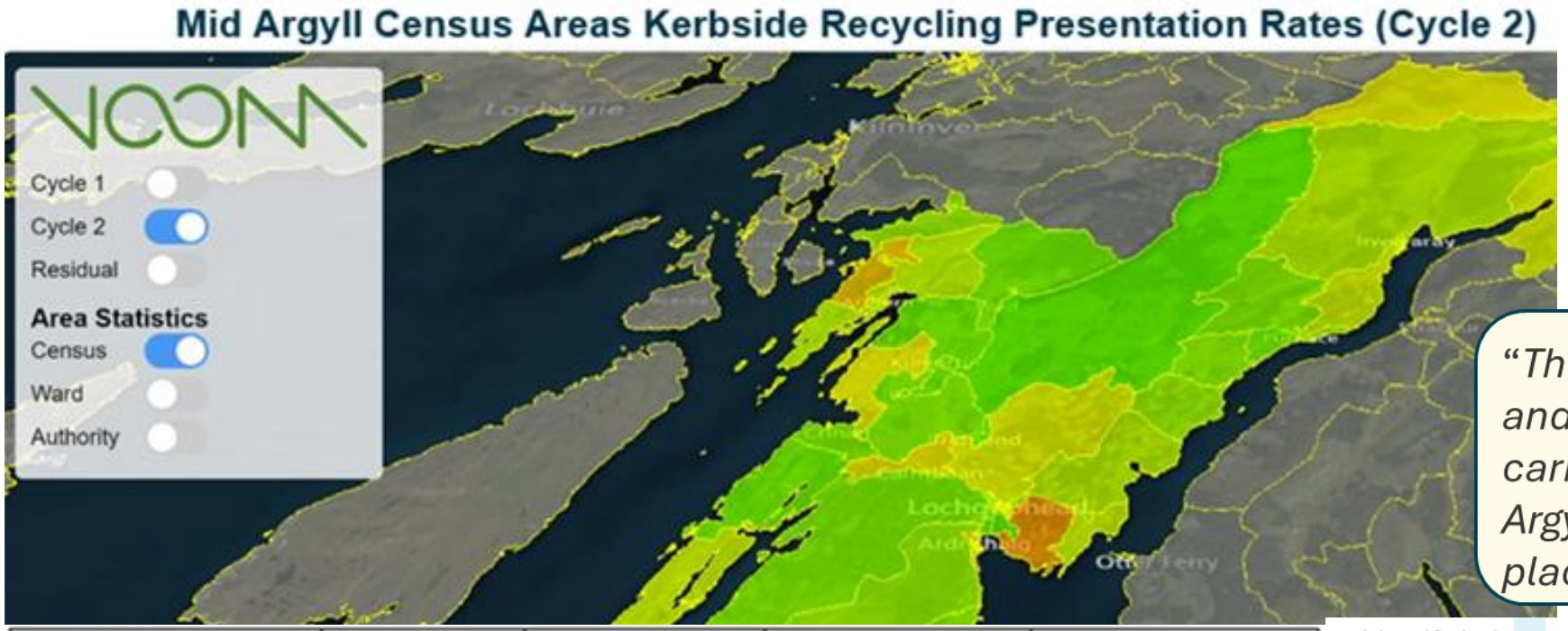
GPS Data

Route details

Tip weights

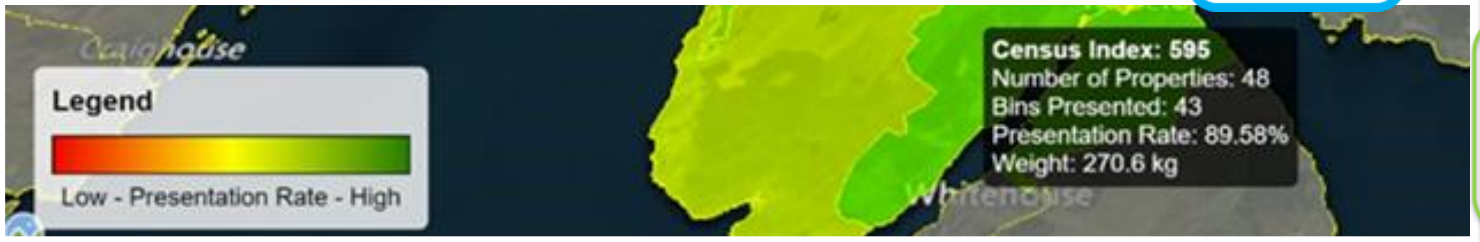
Lochgilphead Kerbside Recycling Bin Lift Details (Cycle 2) 12/09/2024

AI Bin Identification Pilot Study

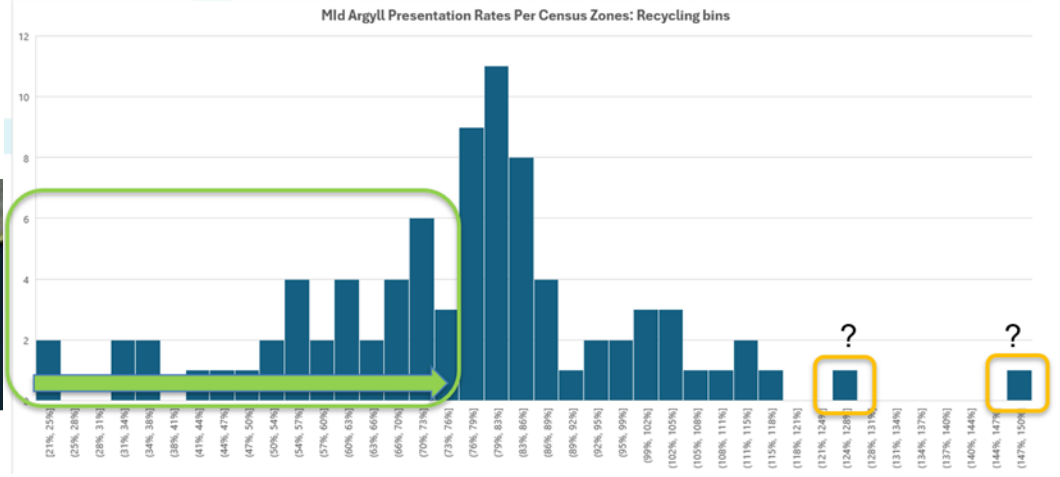


> *"The Voom study has been useful, and the results have been used to carry out several actions in the Mid Argyll area where the pilot had taken place"* A&B feedback

Round	Total Households	Total bins collected	Set out rate	Estimated participation rate
Residual	5,073	4,729	93.2%	
Recycling Cycle 1	5,073	3,840	75.7%	93.2%
Recycling Cycle 2	5,073	3,786	74.6%	92.1%



- Identify below average recycling areas



AI Bin Identification Challenges

- Access to CCTV hard drives and data transfer required (several hours at depot, unless hosted via cloud).
- Ping rates on tracking system may need increased.
- Initial setting up of mapping requires resources but once created surveys can be repeated with new data.

Emerging Technologies

AI for Waste Composition Analysis (WCA)

Potential for Computer vision & machine learning

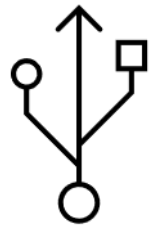
- Cameras at reception area. Material spread out to avoid blind spots.
- Sample households or whole rounds measured.
- Repeatable to measure intervention impacts.
- Objective quality score to inform MRF operators and others.
- Alternative to expensive manual projects that sample small numbers.

Technology providers: None yet but providers such as Lixo are investigating in response to customer interest.

AI for WCA Challenges

- Not yet proven and lack of enough item/material types identifiable but number of items 'learned' is increasing.
- Large amounts of data to be stored and analysed.
- Cost and maintenance of hardware and software. Will systems be permanent on sites or mobile systems brought in temporarily?

Yet to be explored.



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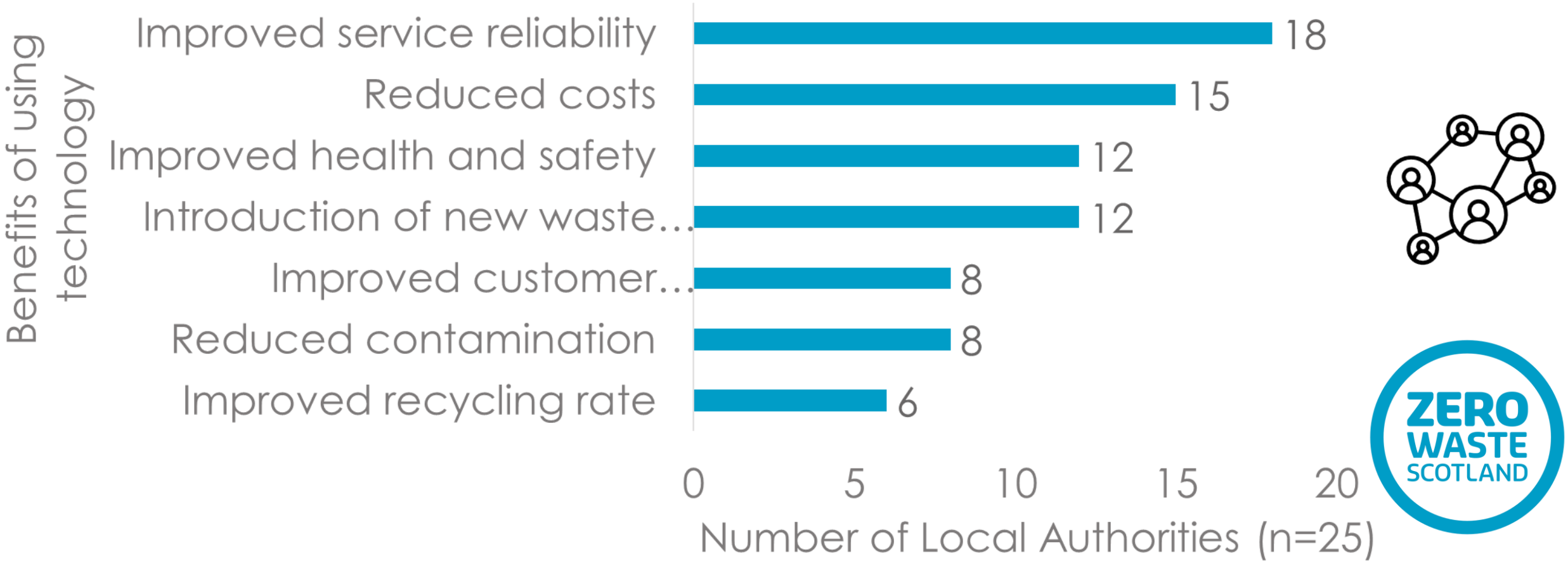
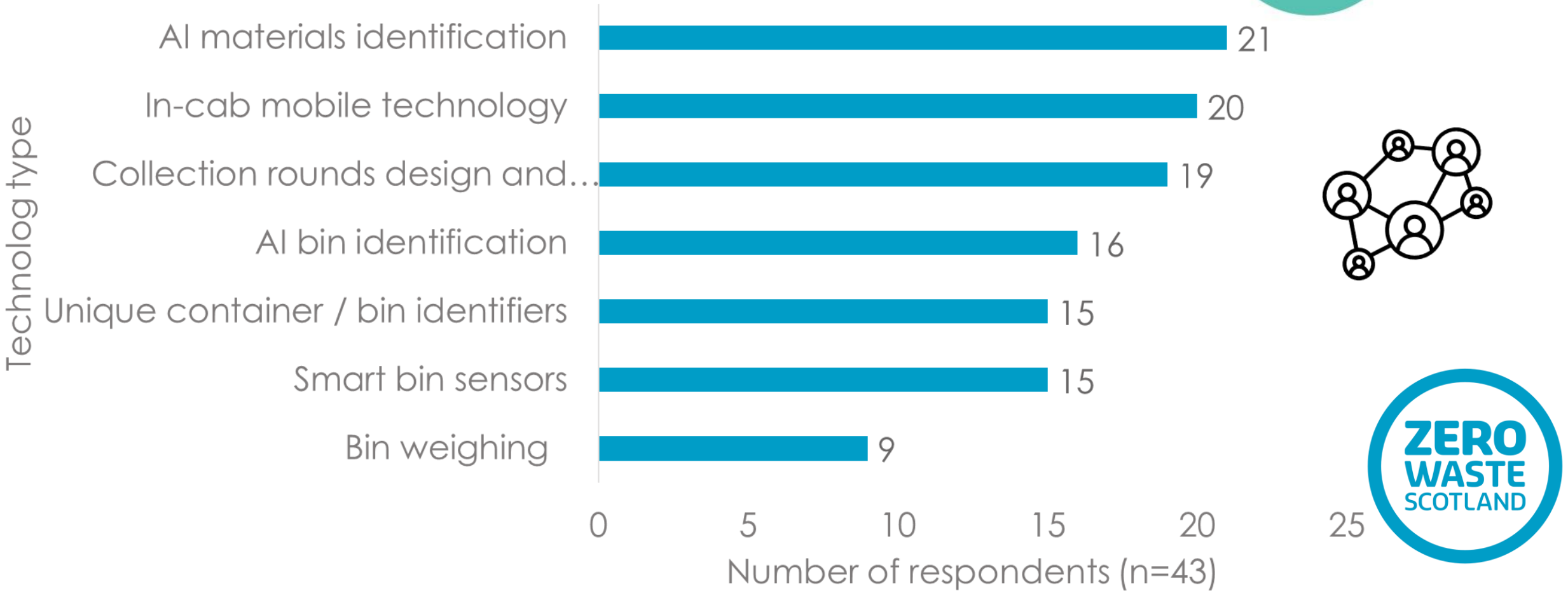
Webinar poll insights

If you use or have used any technology, what benefits has your organisation seen as a result? (25 unique LAs responded to this question)



Which technologies are you most interested in finding more about?



Future support

- What is the best way of supporting LAs?
- Is there appetite for a technical forum for LAs and Zero Waste Scotland to share knowledge experiences and insights?
- Would any LAs consider a trial/pilot study, with ZWS support, for any of the technology types discussed? Or other technologies?

Thank you

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