

wasteinprogress

# Less waste & more recycling?

## How to use smart waste systems and RFID-technology to create sustainable behavior change.

### Insights from a pilot project in Stockholm.



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Technical Manager





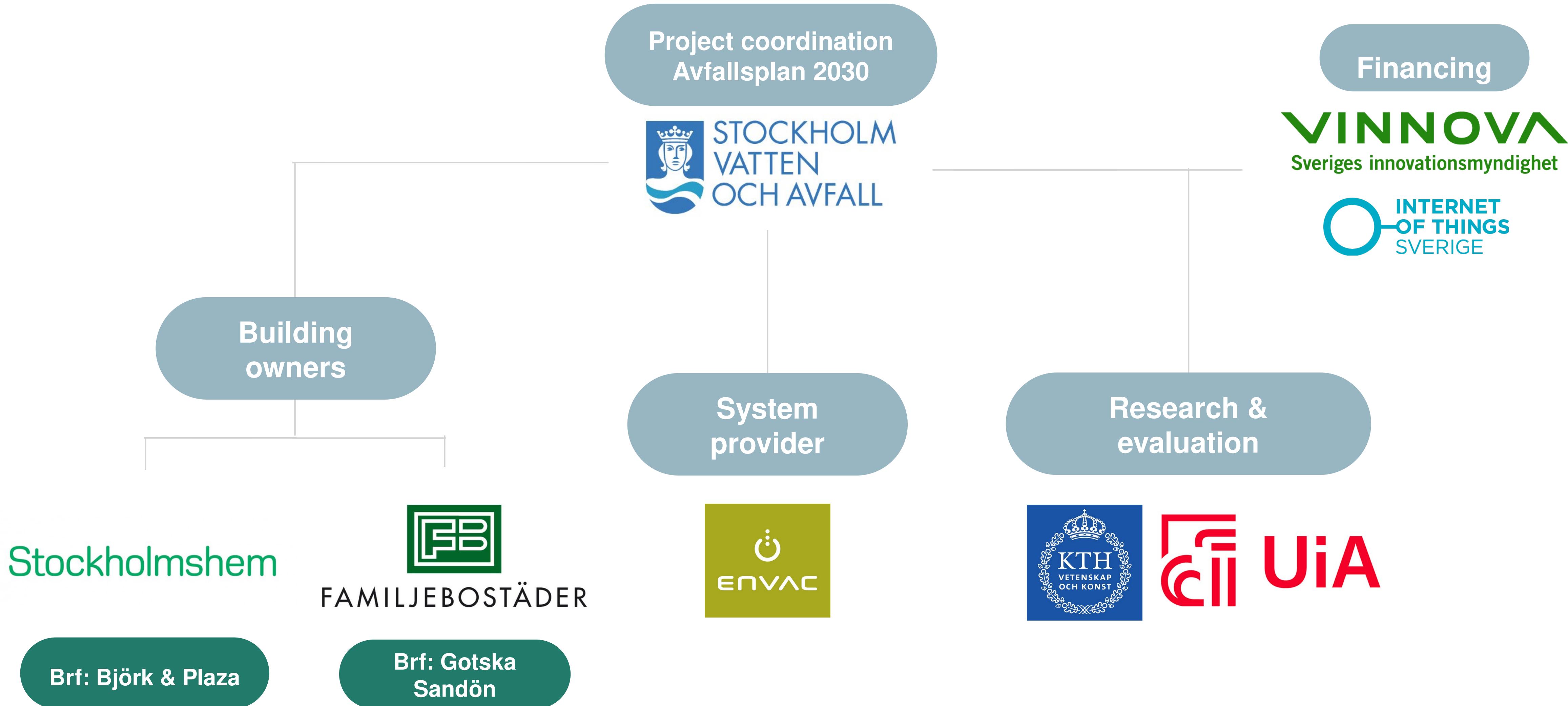
# ABSTRACT & OVERVIEW



# Abstract & Overview

- Results from pilot-study & overview of ongoing research
- **Objective:** increase recycling and reduce share of recyclable materials in household waste
- **Location:** new city development area in Stockholm, former harbor area located close to water & inner city
- **People:** younger, more educated, wealthier & more kids than average in city
- **Data:** weight-data & opening frequencies for plastic, paper and waste collected by RFID-enabled "smart" waste chutes
- **Pilot-study:** 153 households over 12-month study period; results show increased recycling, stable household waste

# Project partners & stakeholders

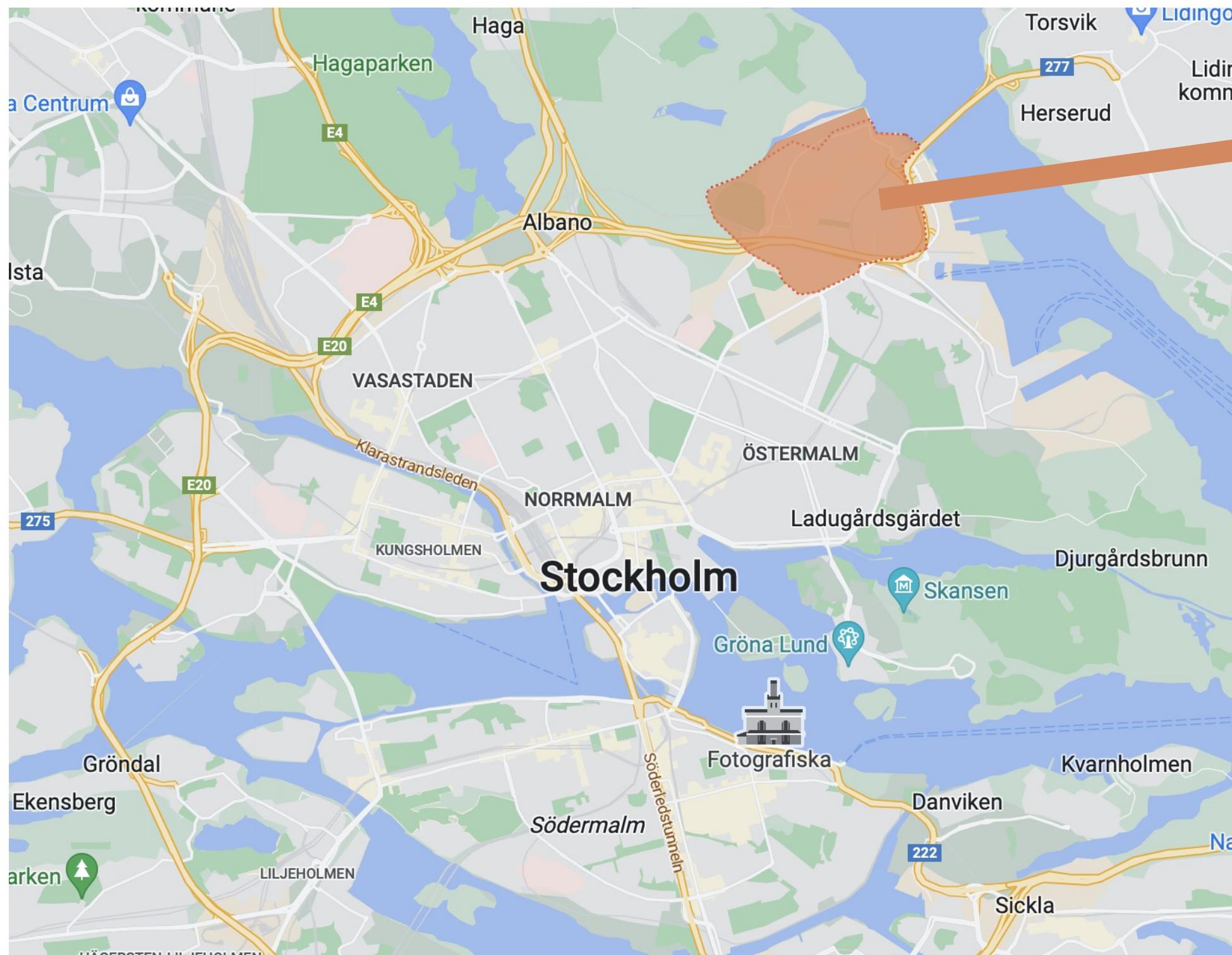




# BACKGROUND & SETTING

# Background & setting

- “Stockholm Royal Seaport” (SRS)



# Background & setting

- “Stockholm Royal Seaport” (SRS)
- new city development in Sweden’s capital (ca. 985,000 inhabitants)
- largest urban development area in Sweden
- focus on resource efficiency & low env. impact
- ≥ 12,000 new apartments
- ≥ 35,000 new workplaces
- multi-residential buildings: 52% rental properties, rest is building associations & cooperatives
- 2.2x bike parking & 0.5x car parking / apartment
- already built: ~ 3000 apartments
- timeline: 2011 – 2030+









# Waste disposal infrastructure

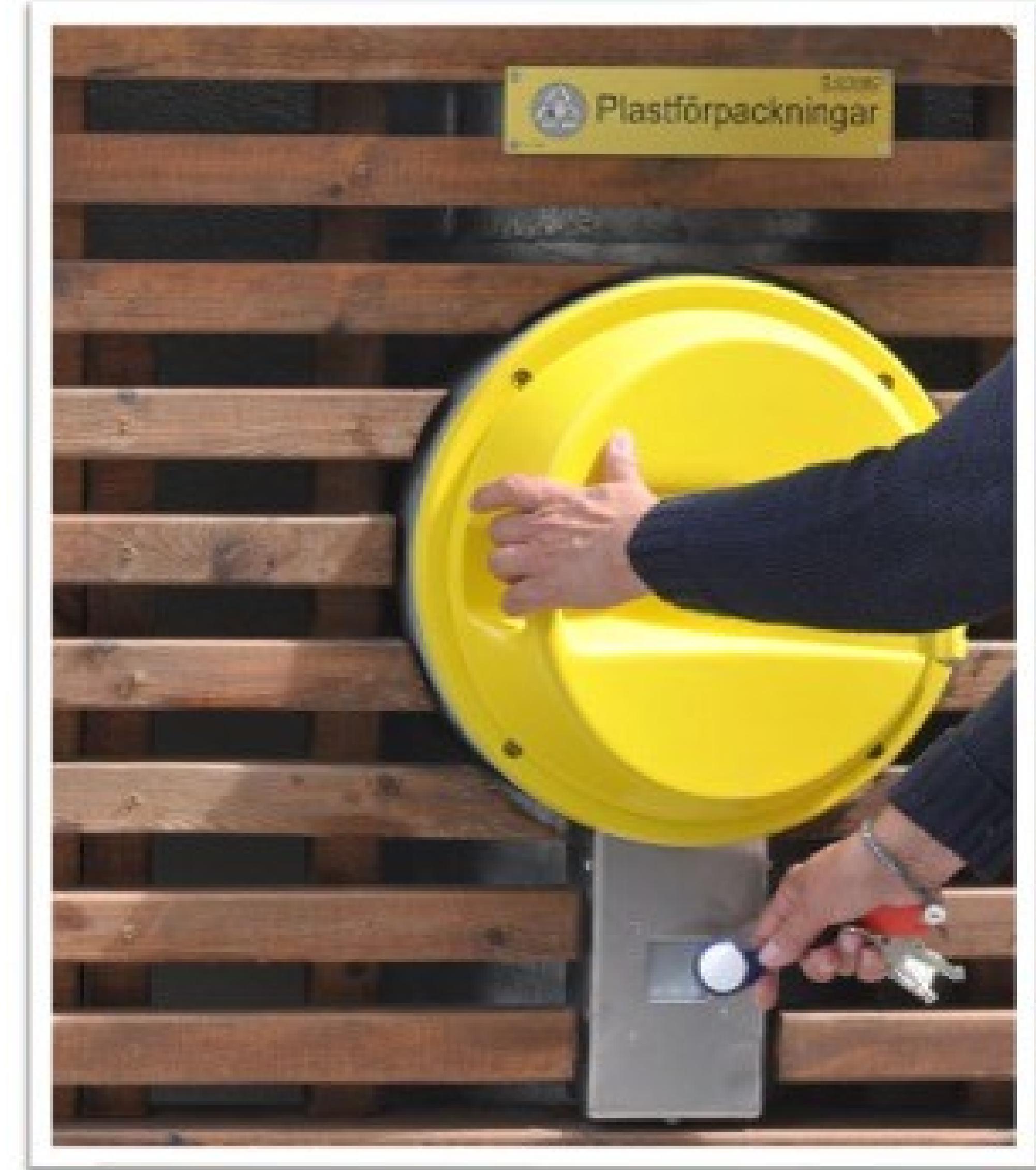
- pneumatic waste collection system for (news)paper, plastic waste, household waste & litter bins in public areas
- 400 waste inlets across properties
- 100 self-emptying litter bins in public areas
- ca. 10t waste / day collected



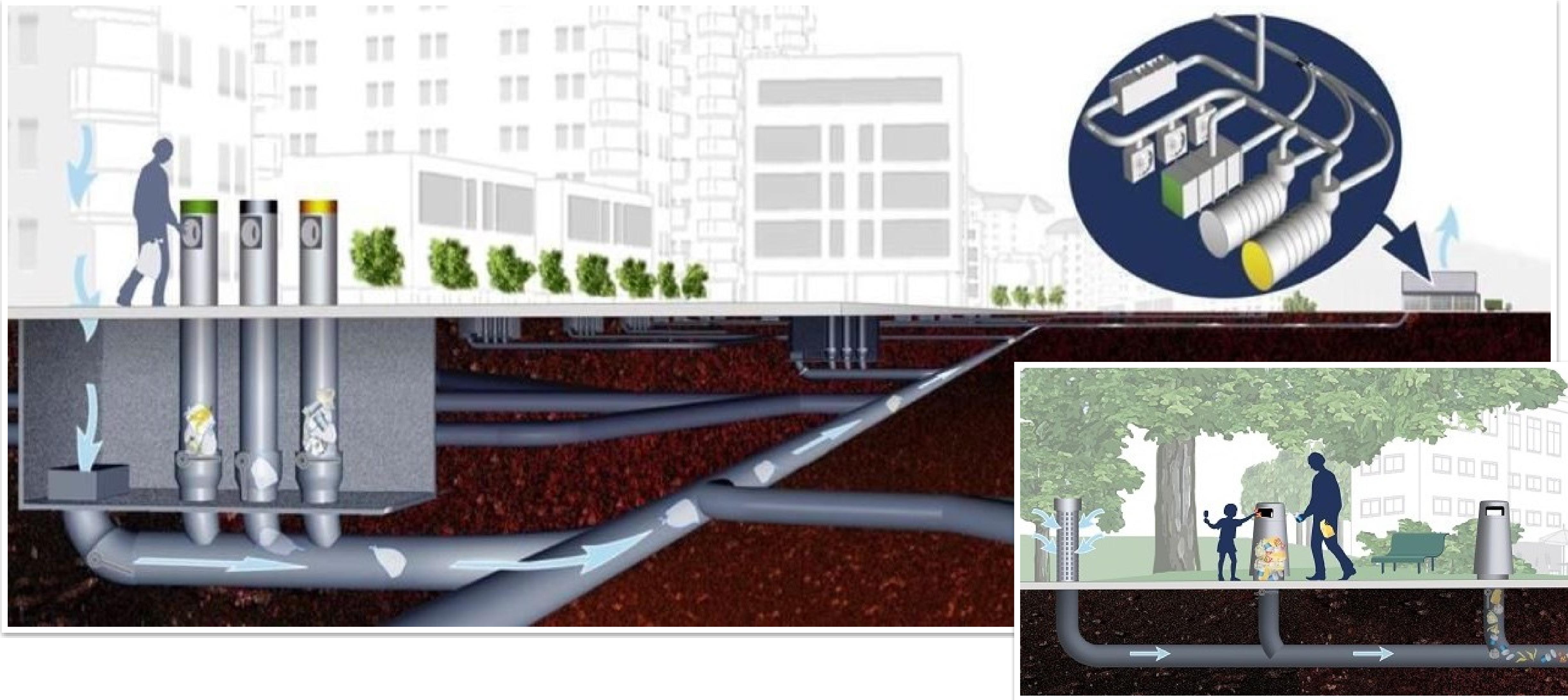
System Operator  
(until 2024)



System Owner



# Waste disposal infrastructure



# Waste disposal infrastructure

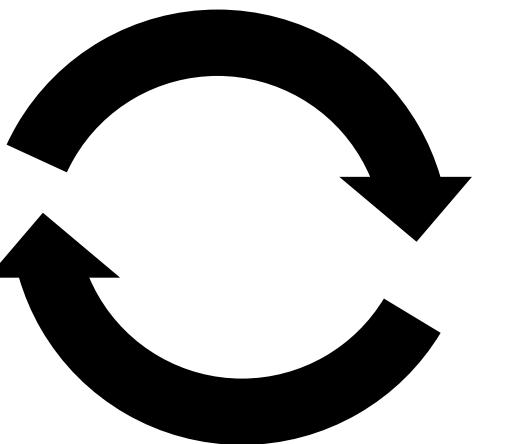


# Waste disposal infrastructure



carton, paper packaging, large plastic packaging items, bulky waste, glass, metal, small electronics, light bulbs, batteries & cooking oil sorted in recycling rooms; food waste disposed through food waste grinders in kitchen sink

# Waste disposal infrastructure



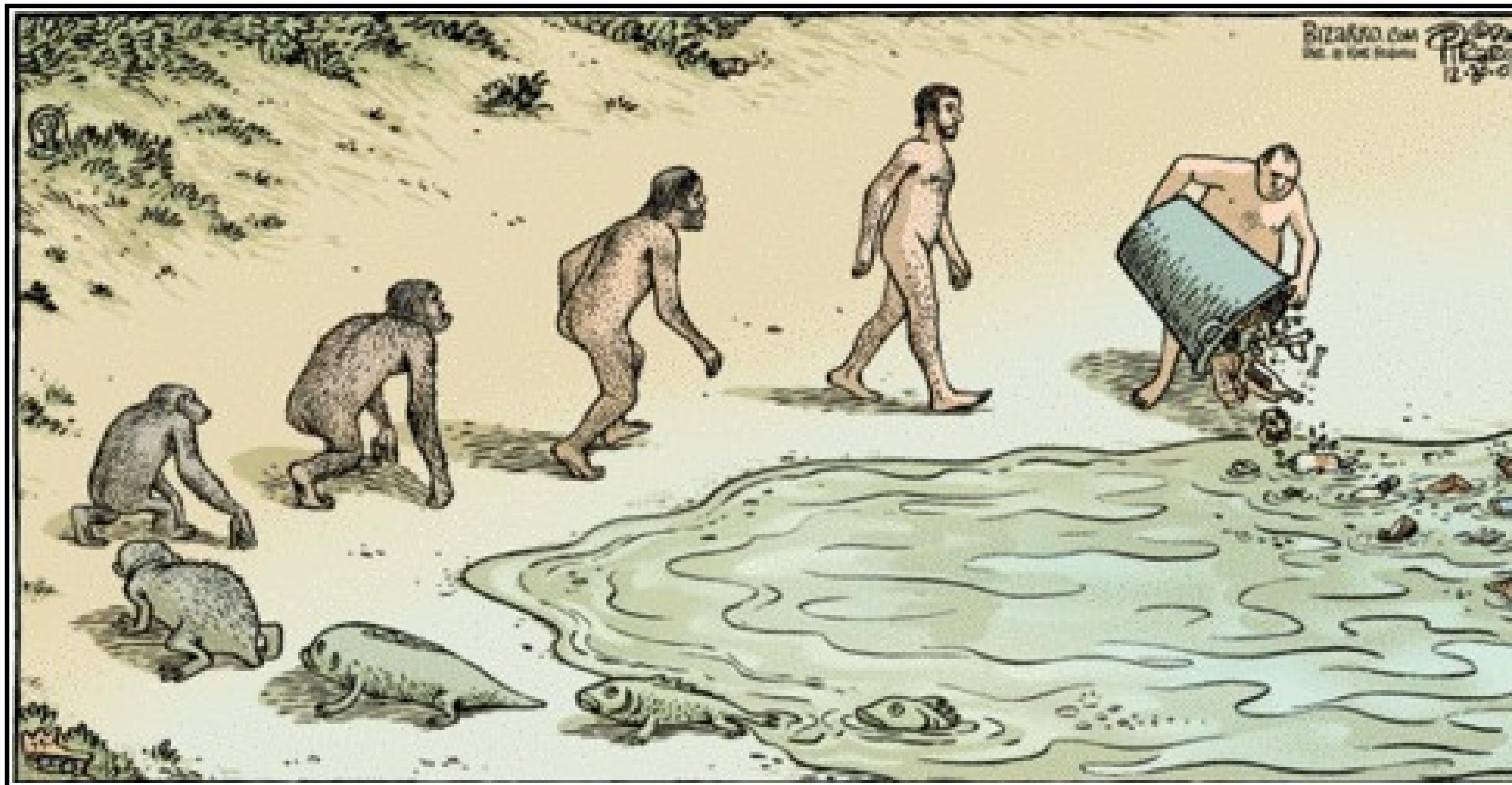
ID	Frequency	Weight
HL0416	3 x	3.6 kg
GS0325	12 x	8.9 kg
PE4387	7 x	2.2 kg

- RFID-keys enable household-level data collection
- opening frequencies for all fractions
- integrated scales for household waste in pilot area
- weight estimates for other fractions in pneumatic waste system



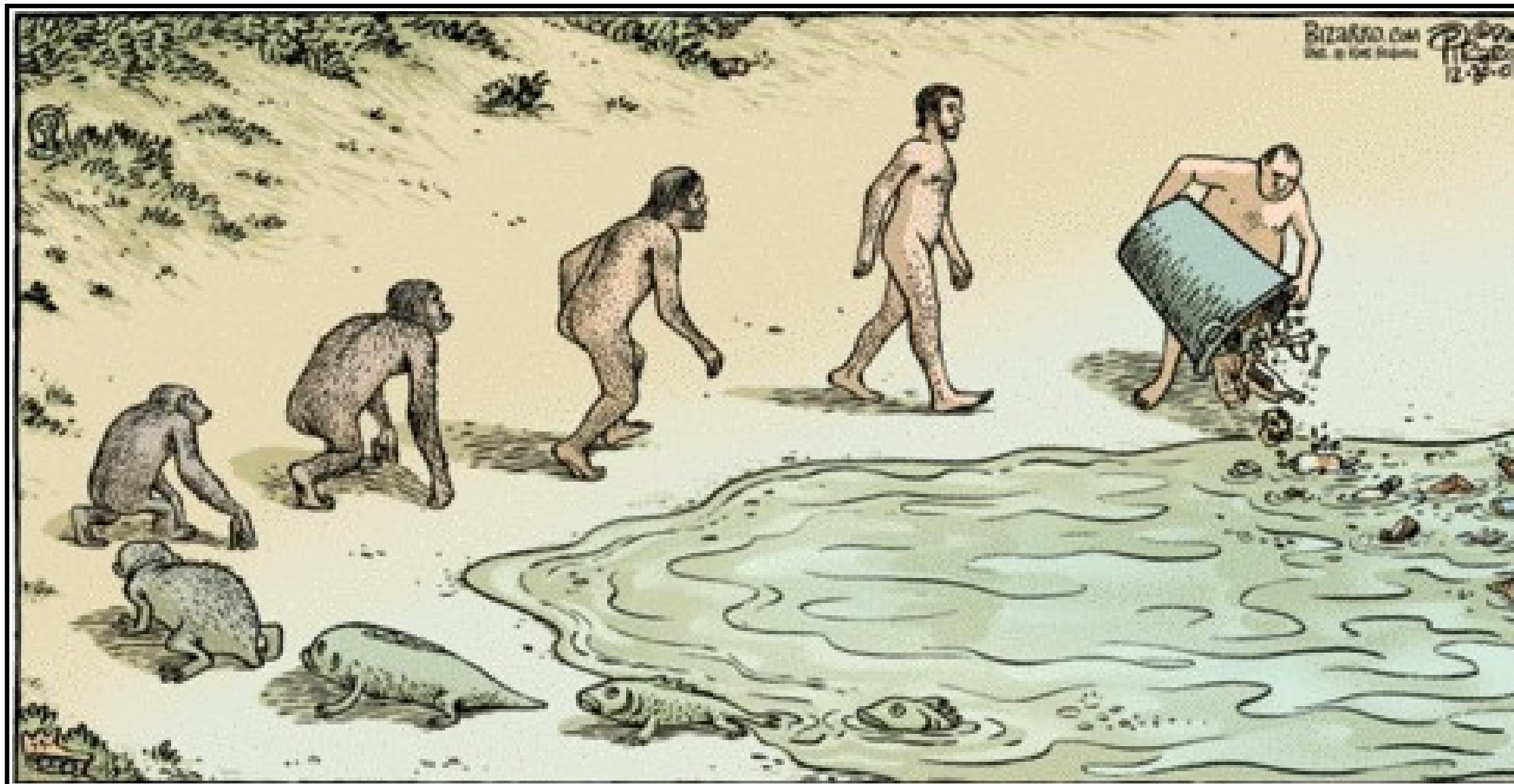


# BEHAVIORAL INTERVENTION & PILOT PROJECT



© Dan Piraro Bizarro

**Some words about  
us humans...**



© Dan Piraro Bizarro

## Some words about us humans...

- basically still cave (wo)men
- **not always rational!**
- programmed to save energy
- prefer short-term gains
- influenced by what others do
- influenced by our environment

# System 1

—intuitive & instinctive—

95%

quick  
parallel  
automatic  
effortless  
daily decisions  
habits  
learns slow

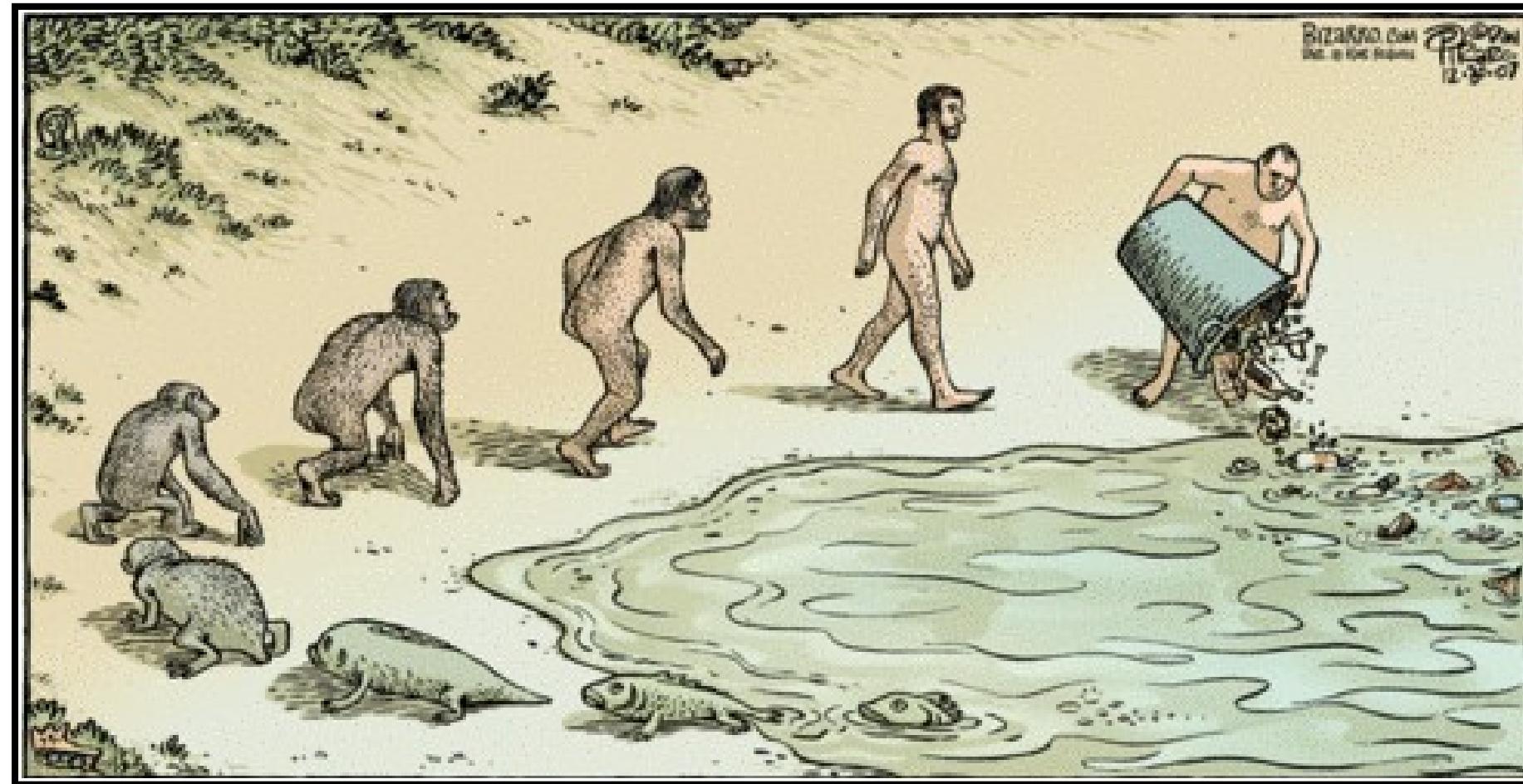


# System 2

—rational—

5%

slow  
serial  
controlled  
requires energy  
complex decisions  
rational actions  
flexible & fact oriented



© Dan Piraro Bizarro

## System 1

—intuitive & instinctive—

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## System 2

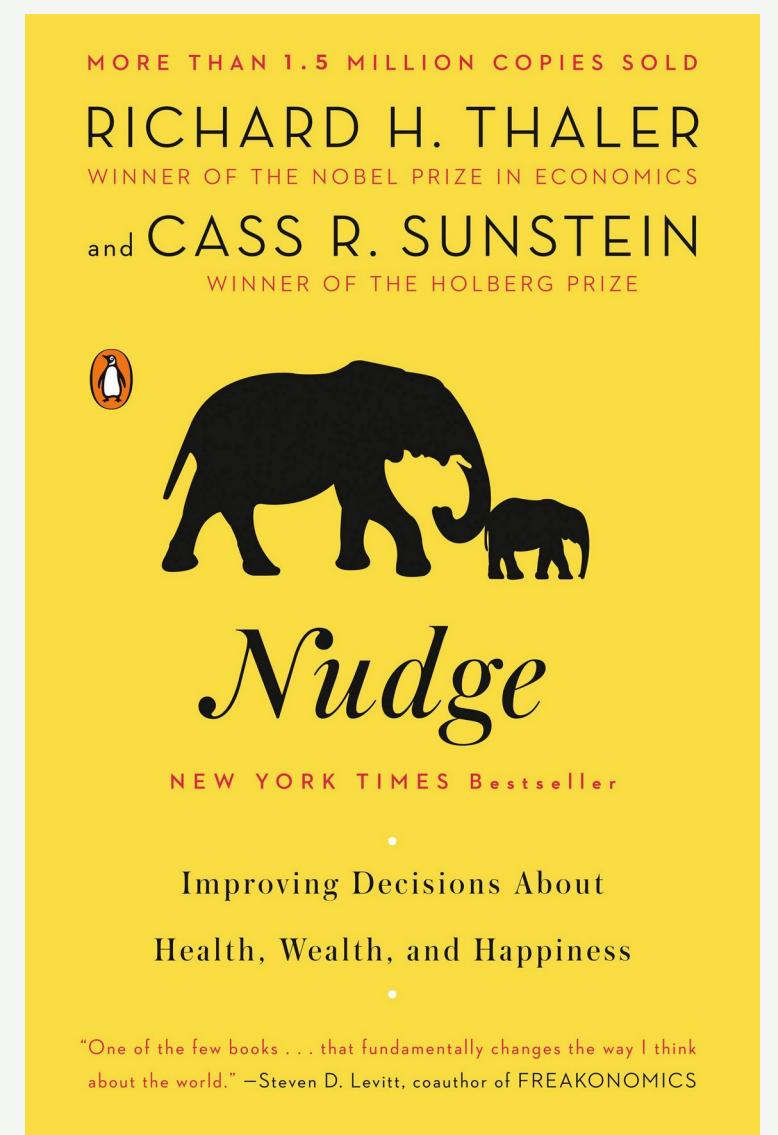
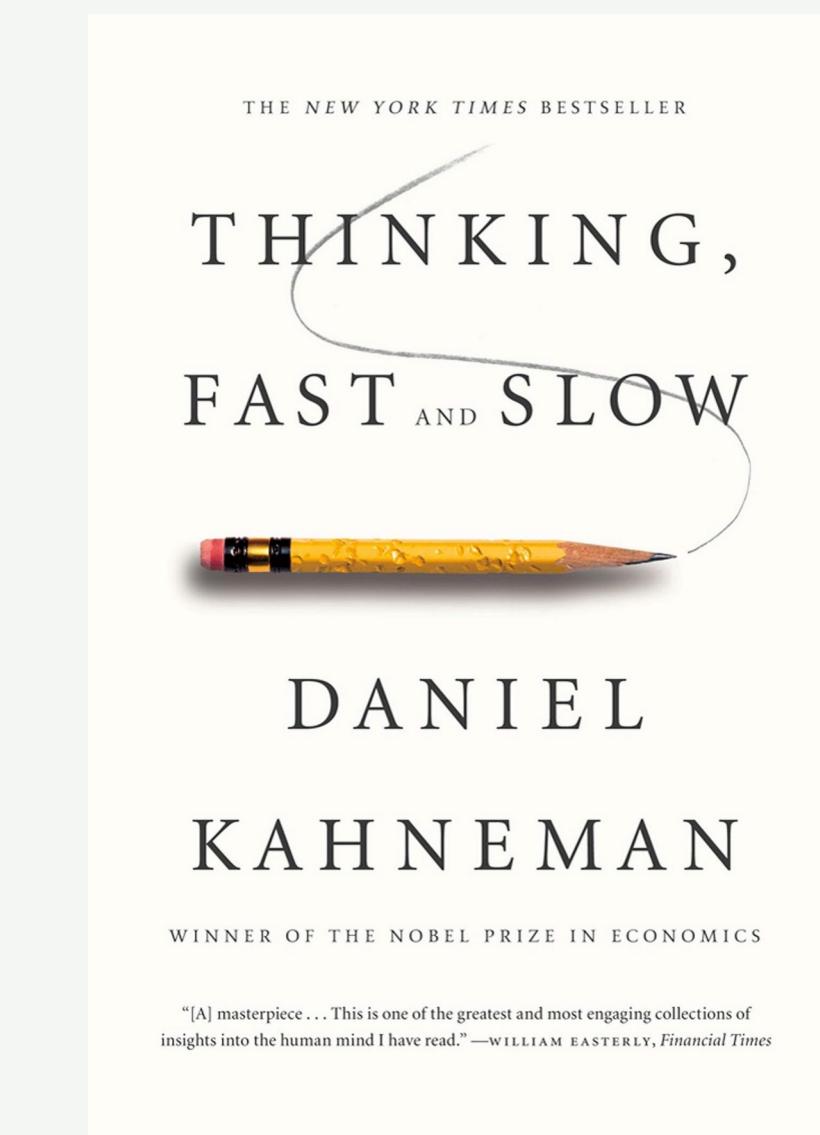
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- information is not enough
- various starting points for behavior change



# Behavioral barriers connected to waste sorting

- a lot of effort – requires constant work & good preparation (e.g., bins)
- no short-term gains – essentially no gains at all!
- often complicated and annoying
- others are poor role models
- “my behavior does not matter”



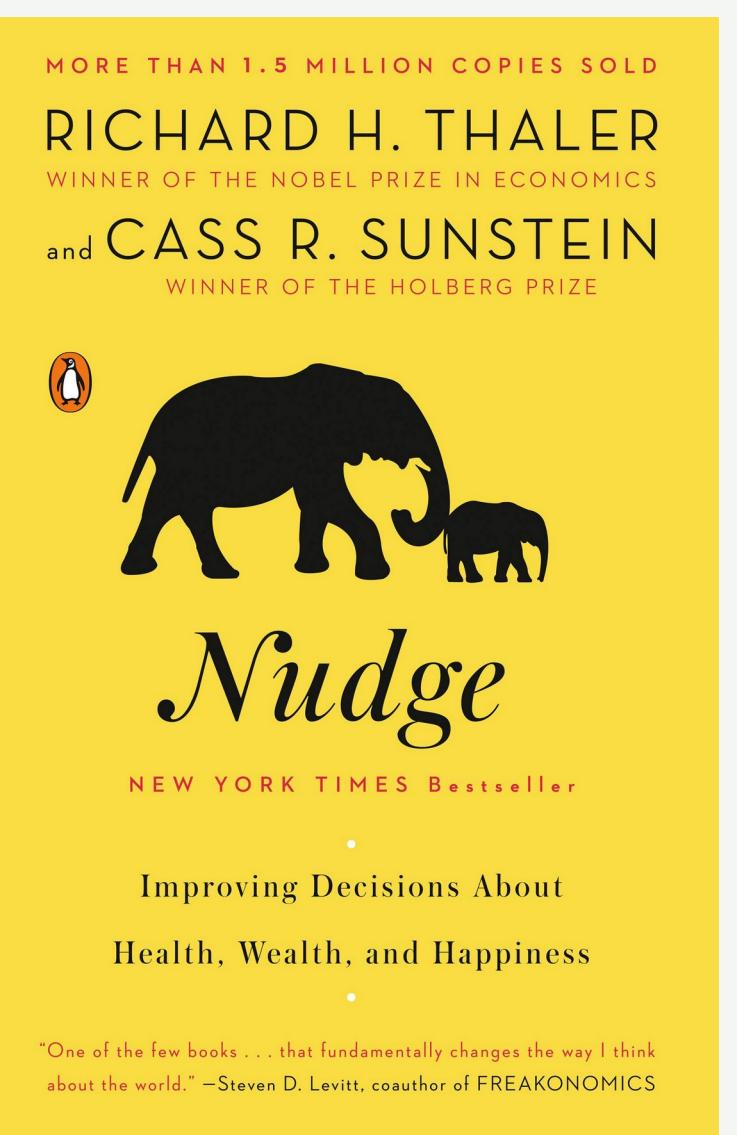
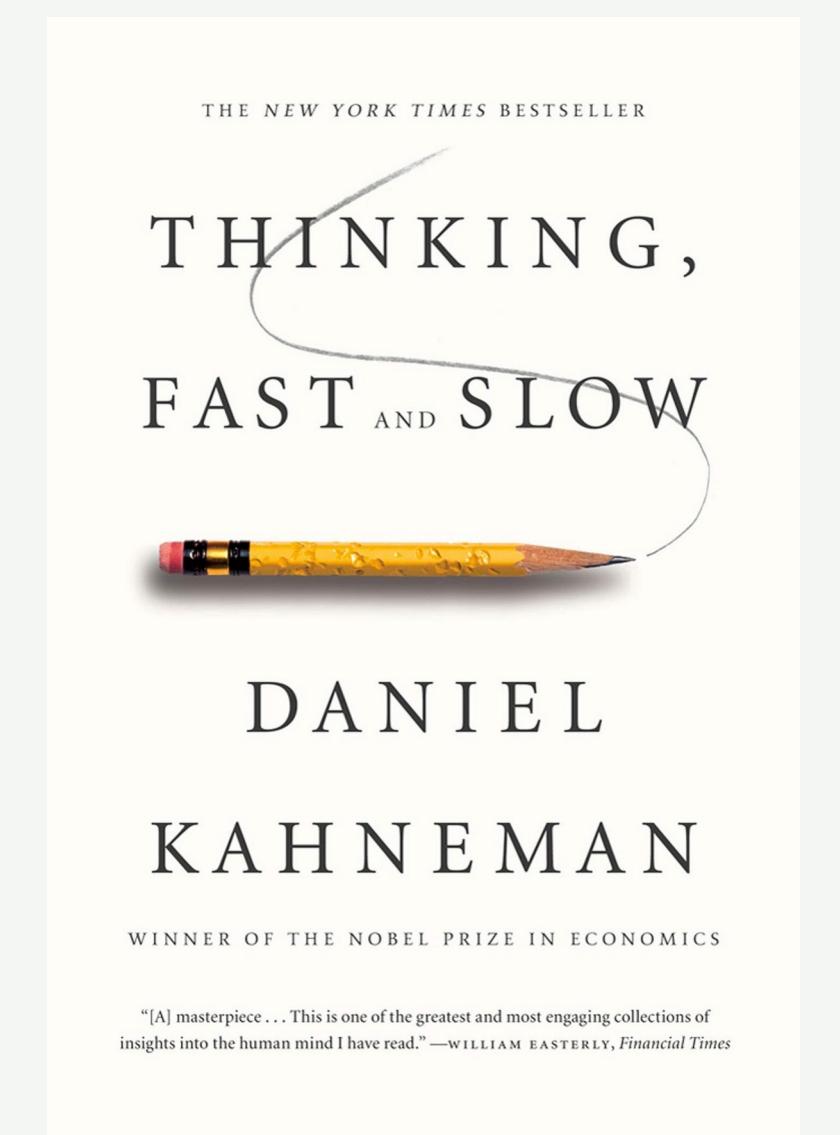
# Potential strategies to overcome barriers & influence household waste behaviors:



Feedback & social norms



Make the desired behavior easy



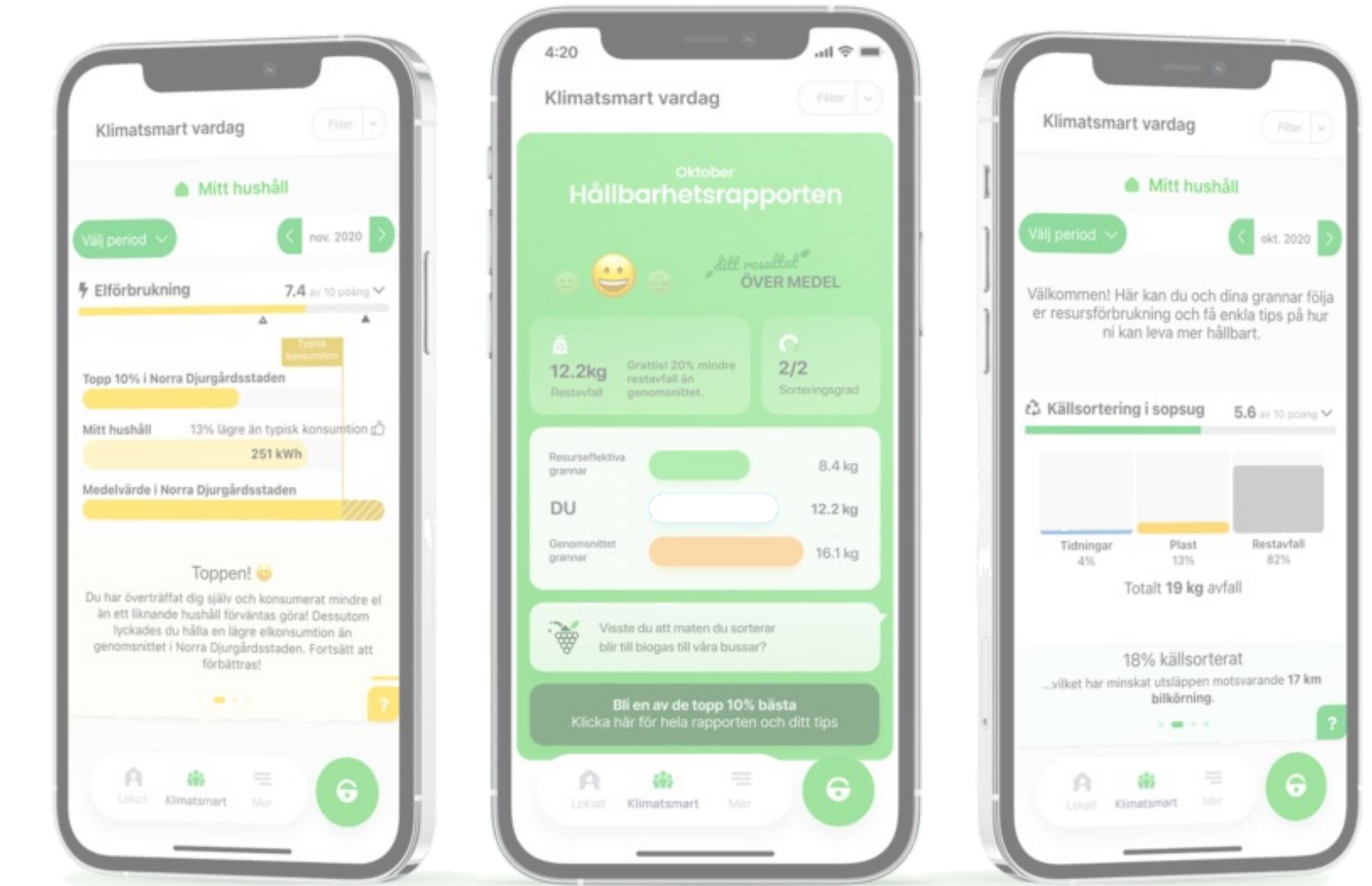
# Why feedback & social norms?

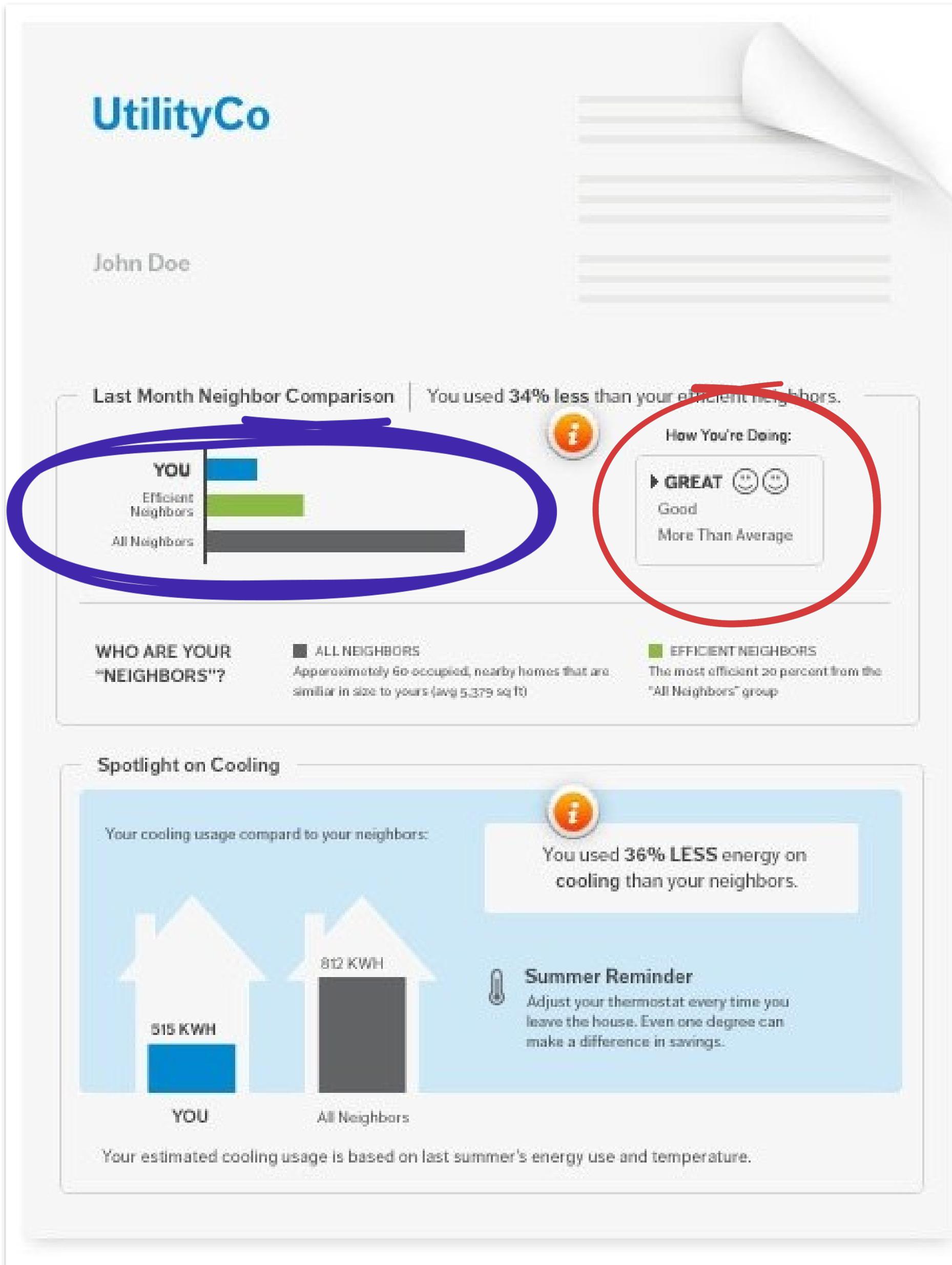
- lack of natural feedback loops  
(Princen 2001)
- humans are social animals:
  - we follow the behavior of others
  - we care about what others think of us
- 2 types of norms:
  - **descriptive norms**
  - **prescriptive norms**



# Social norm interventions: theoretical foundation

- Norms need to be *activated* to influence behavior (Cialdini et al., 1990; Schultz, 1999)
- Activation through salience, e.g., social comparison feedback (Allcott, 2011)
- Descriptive & injunctive norm elements combined to avoid rebound effects (Schultz et al., 2007)
- Reference group relevant and personally & contextually comparable (Goldstein, 2008)
- Use of dynamic reference values to make changing aspect of norm salient (Sparkman & Walton, 2017)
- Communicated implicitly to avoid clear sender & psychological reactance (Bergquist et al., 2019)





## Analog example (electricity focus): *oPower - Home Energy Report*

Result:  
ca. -2% electricity consumption

# Making the desired behavior easy

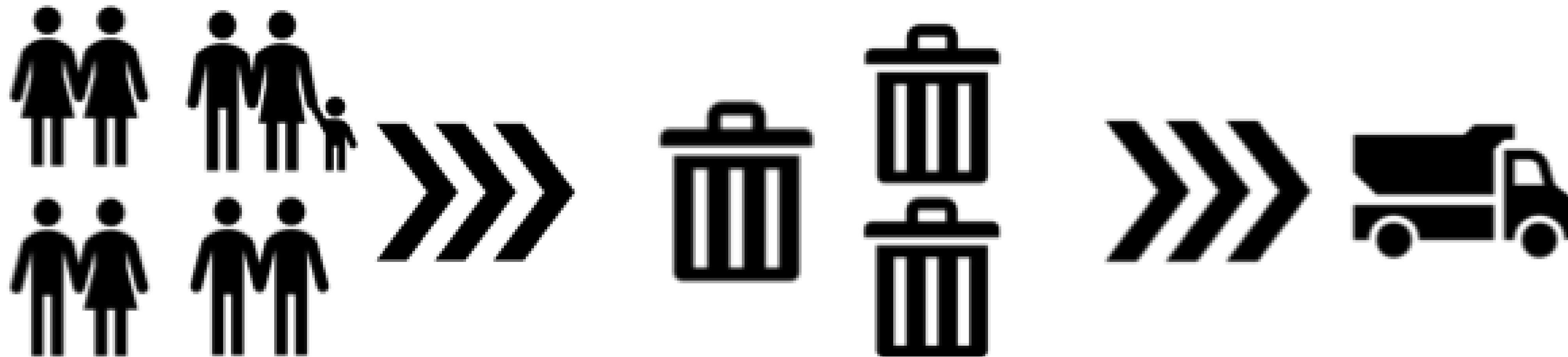
- clear & congruent instructions
- sufficient preparation – waste bags, bins, ...
- require as little effort as possible

- congruent color-coding
- optimized waste collection infrastructure at home
- low friction in process – collection stations nearby, special waste services easily available (e.g., bulky waste)

# Making the desired behavior easy







14:09

Signal Strength Wi-Fi Battery

## ≡ Sustainable living

My household

Choose period ▼

< juni 2021 >

Welcome! Here you and your neighbors can follow your consumption of resources and get simple tips for living sustainably in everyday life.

### My household

#### ♻ Recycling

7.2 of 10 points ▼

#### Residual waste

Swedish average  
8.7 kg/p

Top 10% in EXAMPLE BLOCK

1.1 kg/person

#### My household

5 kg/person

Average in EXAMPLE BLOCK

6 kg/person

Impressive! 👍

Your household threw 5.0 kg residual waste per person in juni. This is less than the average amount in EXAMPLE BLOCK. Keep it up!

• • •

?

14:10

≡ Sustainable living

My household

Choose period ▾ juni 2021 ▶

Welcome! Here you and your neighbors can follow your consumption of resources and get simple tips for living sustainably in everyday life.

## My household

 **Recycling** **7.2** of 10 points ▾

Category	Percentage
Paper	3%
Plastic	12%
Residual	85%

**23 kg** waste in total

**15% recycled**  
... which has reduced emissions by the equivalent of **18 km of car driving**

?

Buildings + Store Leaf Bell

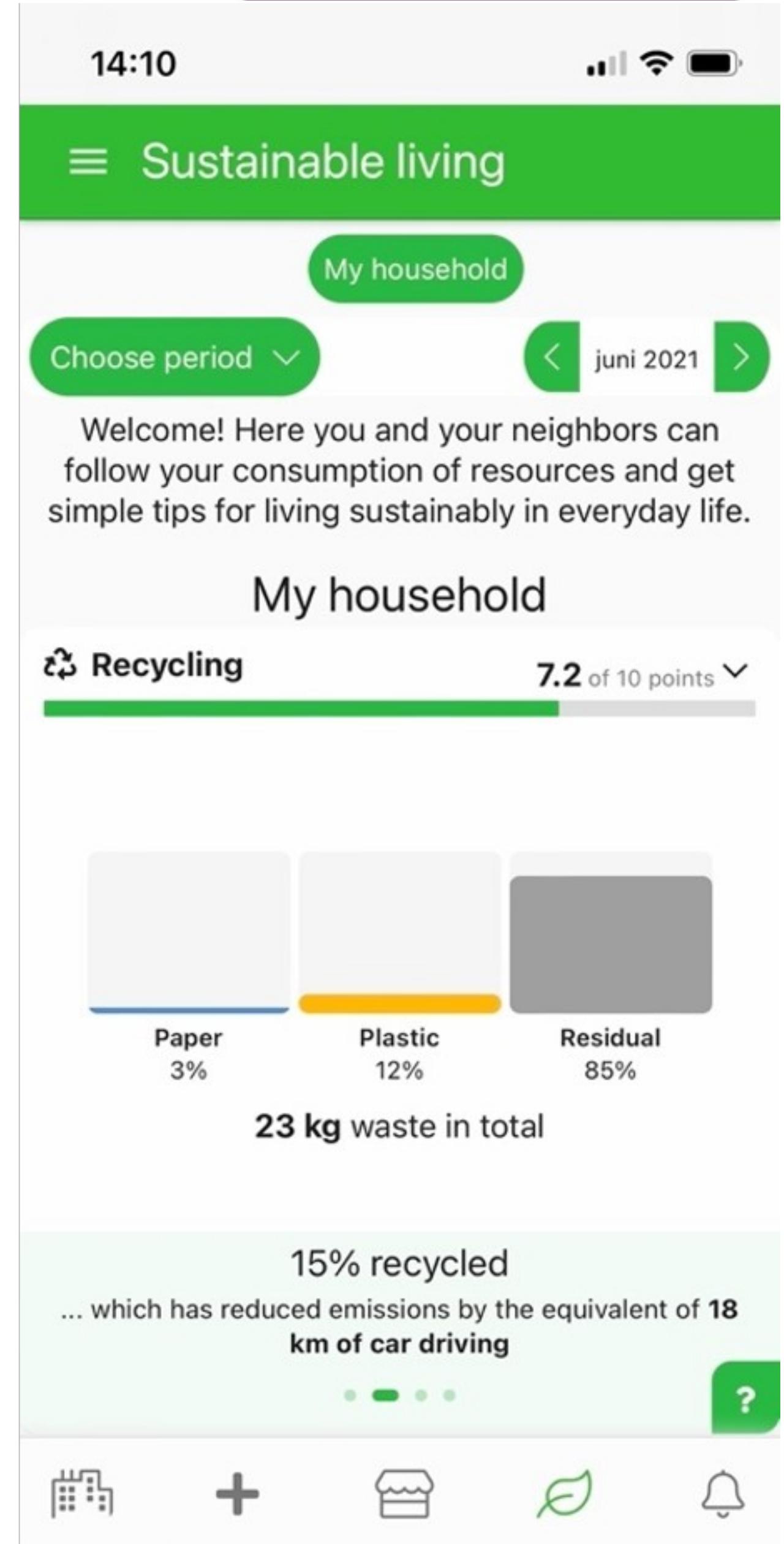
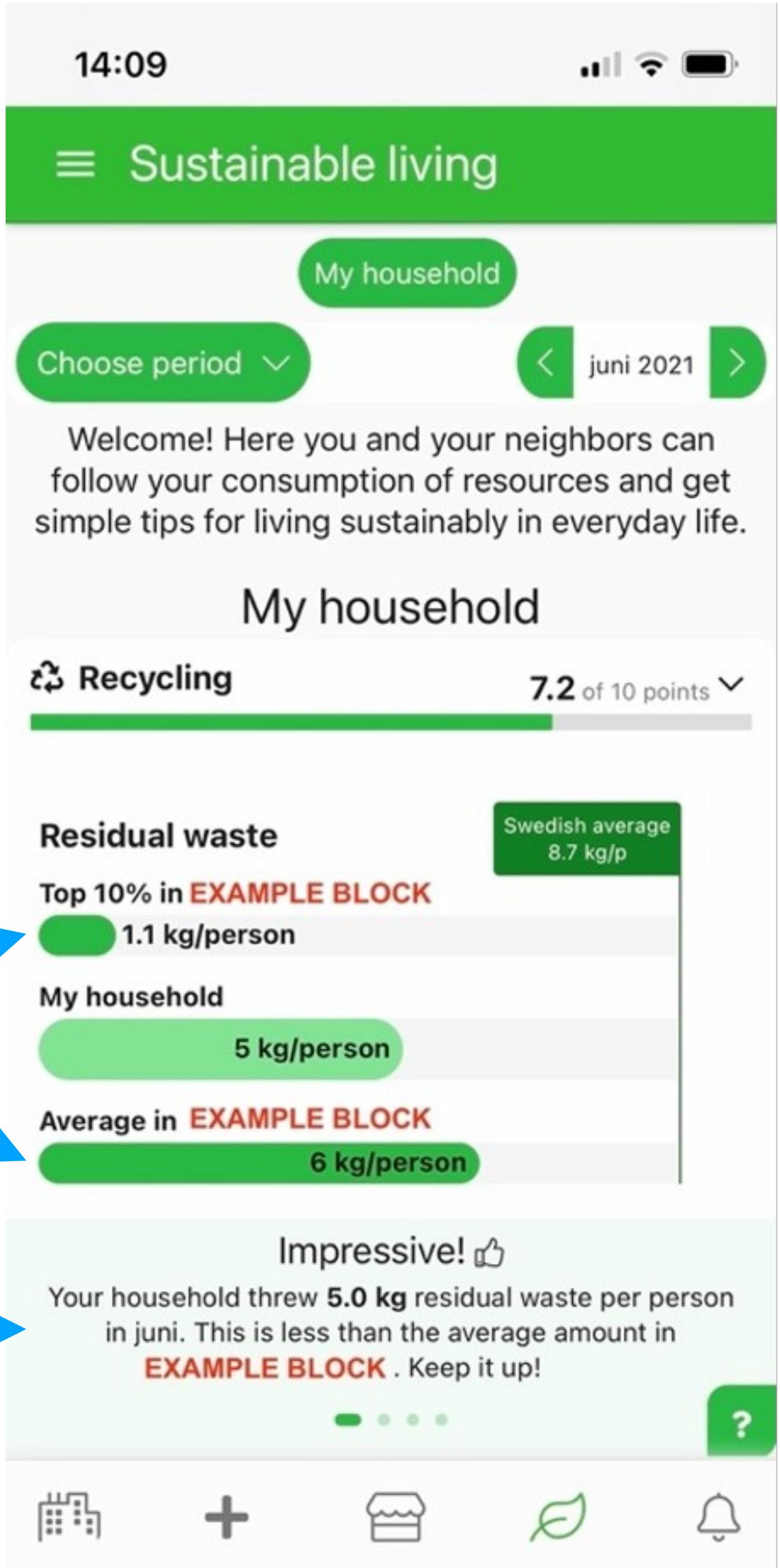
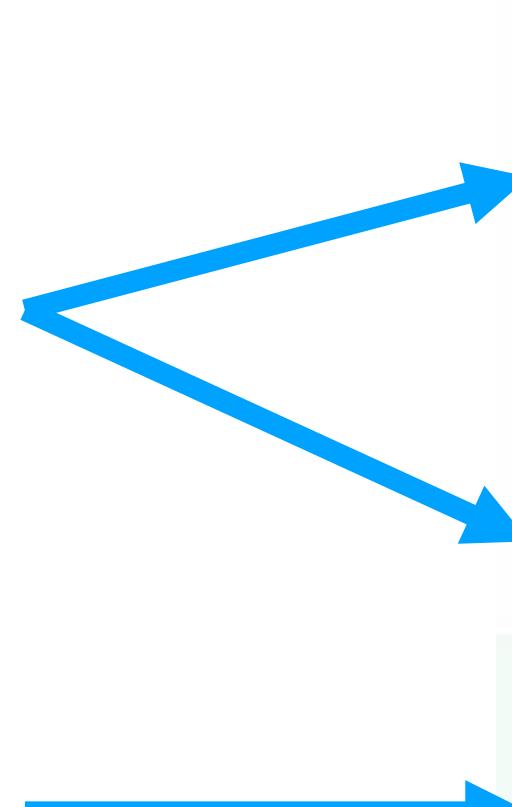
Important to combine descriptive & prescriptive norm to avoid rebound effects.

### Descriptive norm:

Comparison to neighbors with lowest amount of household waste & average neighbors

### Prescriptive norm:

Overall evaluation: good / ok / bad ?



Top 10%

**Above average**

Below average



### Your progress

- better than the average neighbor
- not as good as last month

Keep up the good work!

#### Unlock your full potential

Click here for the full report & your personal sustainability tip of the month!

[What's this?](#)

**Sustainability Snapshot**  
June 2021

Top 10%

Above average

**Below average**



### Your progress

- below neighborhood average
- better than last month

Next month is a new chance to improve!

#### Get back on track

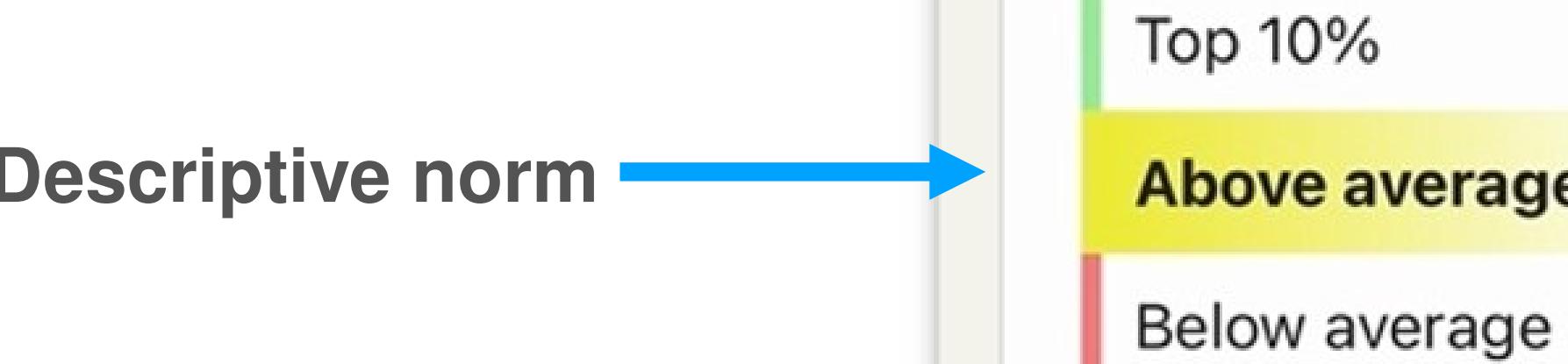
Click here for the full report & your personal sustainability tip of the month!

[What's this?](#)

**Sustainability Snapshot**  
June 2021

Descriptive norm

Prescriptive norm



#### Your progress

- better than the average neighbor
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Keep up the good work!

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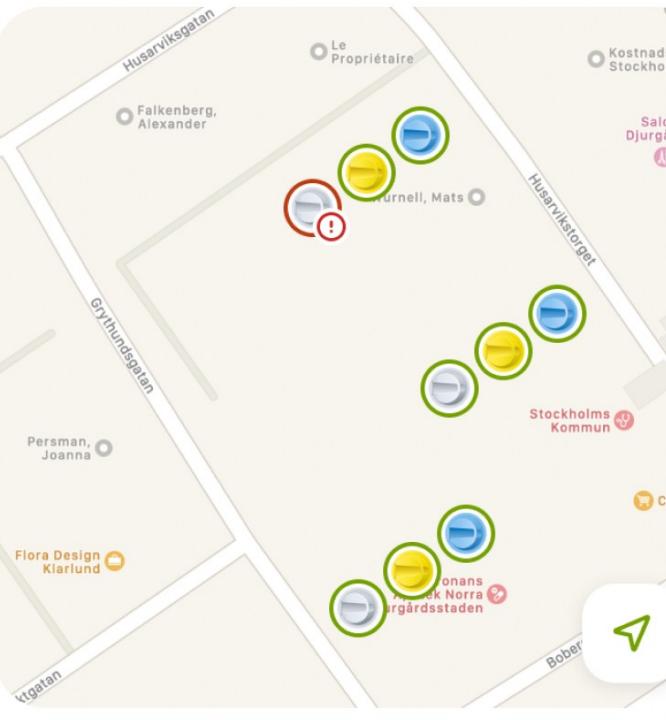
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*Sustainability Snapshot*  
June 2021

## Inlets



**Grythundsgatan 2**

**Residual Waste**  
ID 24:1 · Reported

**Plastic Packaging**  
ID 24:2 · Active

**Envac Digital 10:05**

**Inlet open**

## Grythundsgatan 2

### Messages from Envac

**HORNSLANDET**  
**Are you done with your Christmas tree?**

Leave it at the collection point at Husarvikstorget. It will be turned into biogas and district heating.

Please, don't throw it into the inlets as it may cause blockages.

### TODAY'S TIP

**Unsure how to recycle your chips bag?**

Try squeezing the bag into a ball. If the bag keeps its shape, it is recycled as metal. If it expands, it is recycled as plastic.

### Your inlets

All our inlets are **active**.

### Sustainability Snapshot

**We're doing great!**

Wow! Our building is among the most efficient so far this month.

**Kl. 10:05**  
13:00 15:00

**NOVEMBER 2021**  
**Your Waste**

**HOUSEHOLD** **BUILDING** **NEIGHBOURHOOD**

### Residual waste

**Household**



**AWESOME!**

So far this month you have thrown away **5.6 kg** residual waste, which is about **5 trash bags**.

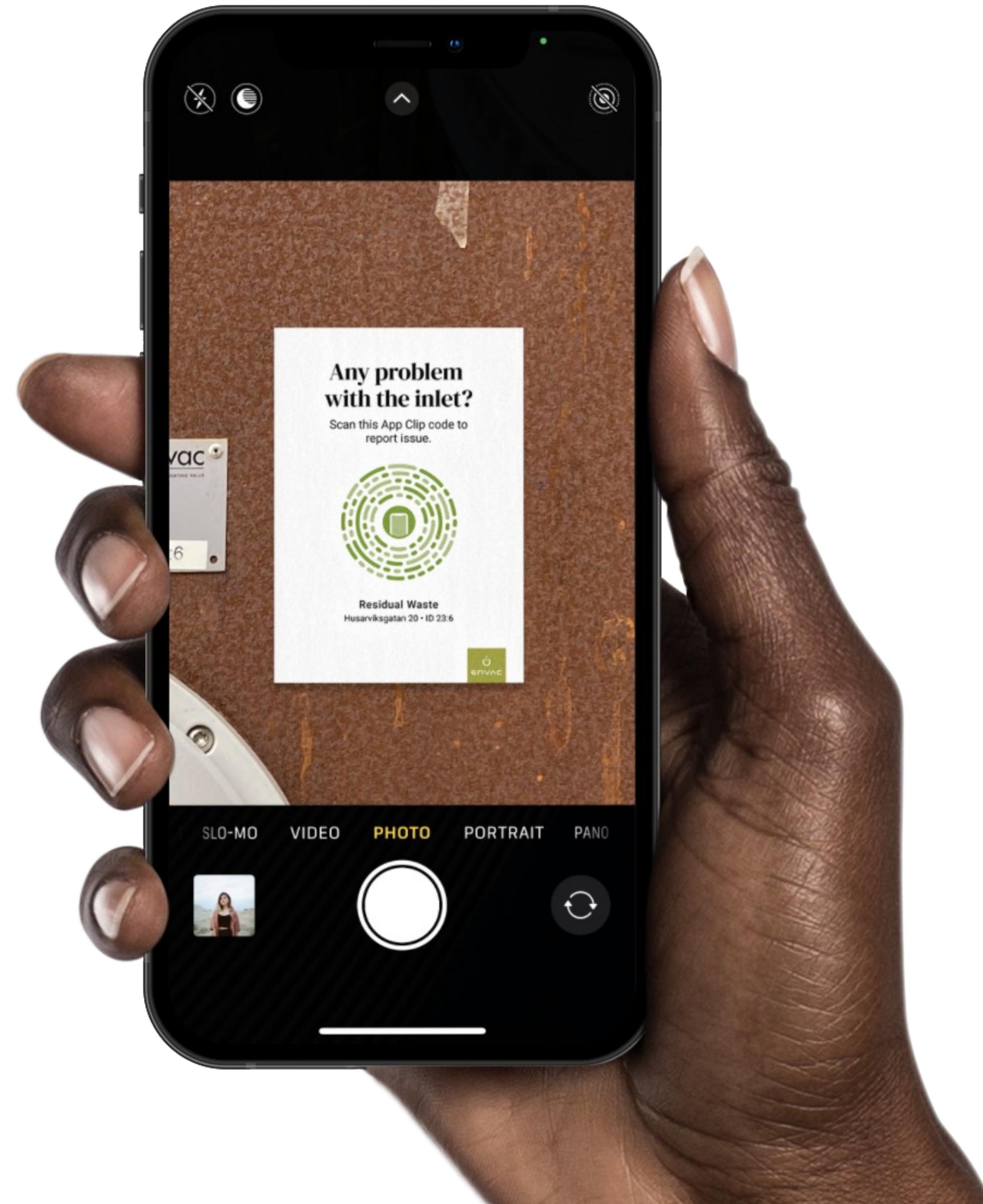
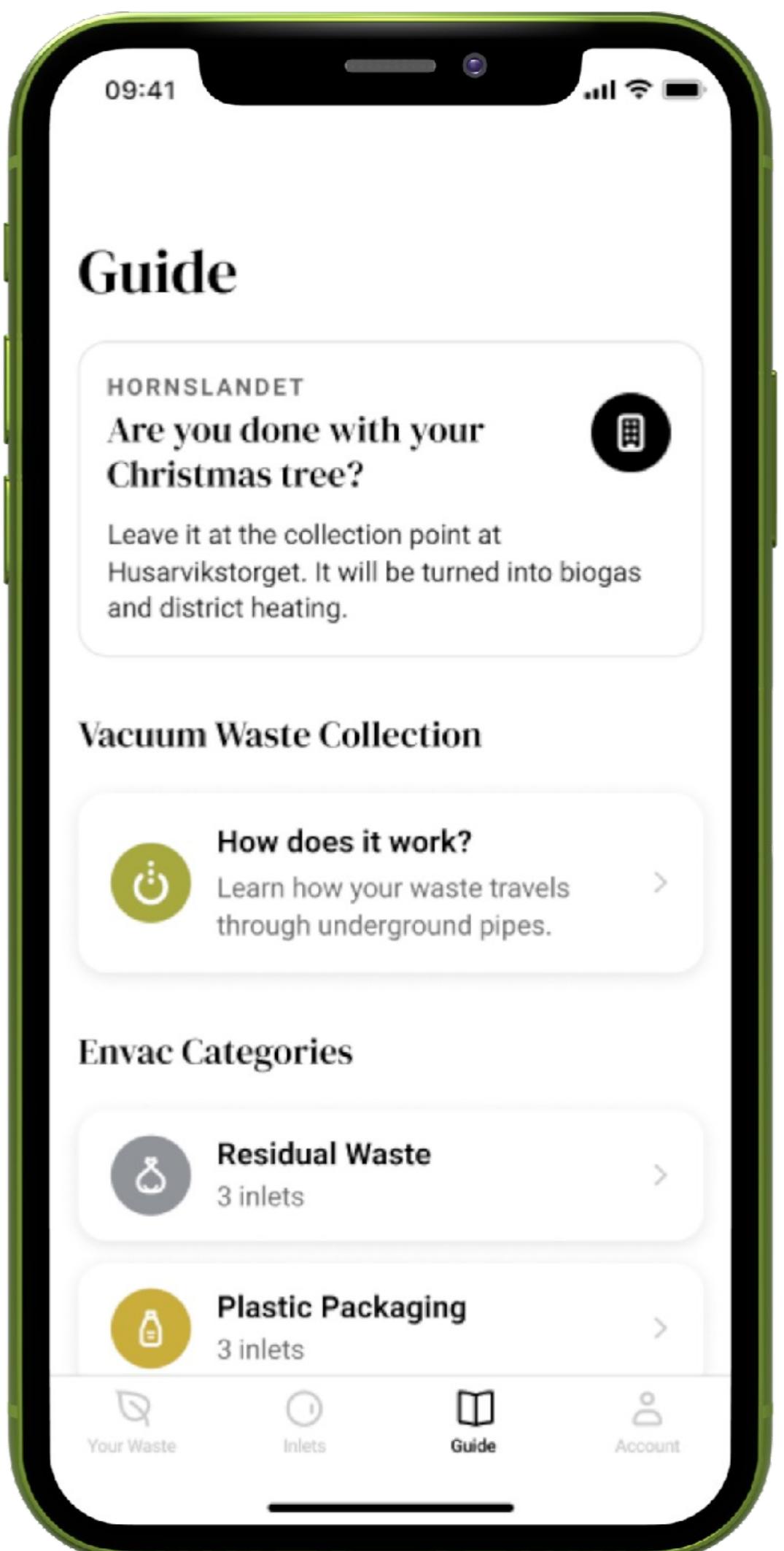
**1.2 kg** less than this time last month

**10%** less than average neighbours

**HOW TO IMPROVE**  
**Remember your waste grinder!**

**Your Waste** **Inlets** **Guide** **Account**

	Residual Waste · Kg per person
<b>Us</b>	3.5 kg
<b>Average</b>	5.2 kg
<b>Top 10%</b>	3.7 kg



# Digital tools offer more functions



- 01 Feedback is more dynamic than with analog media
- 02 Interactive content offers better insights
- 03 More adaptable to needs of different users
- 04 Combined functions can create added value





**Number of  
households**

**Share of app users**  
40%

**Time period**  
06/2020 – 06/2021

**Project focus**  
increase plastic  
sorting  
**Waste fractions**



**UiA**  
Stockholms hem



Nu startar vi! Din inbjudan till boendeplattformen Hornslandet

Du och dina grannar är bättre tillsammans

Under dessa utmanande tider inser vi mer än någonsin behovet av ett väl sammanhållit grannskap. Nu kan du som bor i området aktivera din digitala boendeplattform för kvarteret Hornslandet. Tillsammans med Stockholmshem och Envac driver KTH ett forskningsprojekt för området här i plattformen LocalLife. Syftet är att stärka hållbarheten i kvarteret och lättar vardagen i kvarteret. Flera av dina grannar är redan här du är varmt välkommen att ansluta.

Välkommen till LocalLife Hornslandet!

**Enklare vardag**  
Hjälps åt grannar emellan med tips kring boendet. Nu digitaliseras sopsugen i Hornslandet för att göra det möjligt att se status, en smartare felanmälan, och en karta över andra inlägg.

**Trivsel**  
Du och dina grannar är bättre tillsammans! Hitta varandra så kan ni göra ert område trevligare, tryggare och roligare.

**Hållbart boende**  
Se hur området blir klimatsmartare. Här visualiseras resursåtgärder och ni får konkreta tips på hur det blir bättre. Här är det enkelt att låna, byta, köpa saker grannar emellan.

**PP Sverige, Post Payb**  
Nina [REDACTED]  
Gående undanförhus: 0 hundr

**locallife**

**envac Stockholmsh**  
[www.locallife.se/hornslandet](http://www.locallife.se/hornslandet)  
Bilden på Hornslandet designades av 3D House



**NU ÄR VI  
IGÅNG!**  
**VÄLKOMMEN TILL  
LOCALLIFE HORNS**

Nu är boendeplattformen LocalLife Hornslandet här! Din aktiveringskod hittar du på vykortet du fått i brevlådan. Flera av er som bor i området har redan aktiverat er.

I LocalLife kan du och dina grannar hjälpas åt för att skapa en enklare vardag i kvarteret och området. Här är en kort förstahandsvisning.

## SMARTARE SOPSUG?

**DET FINNS NU I LOCALIFE  
HORNSLANDET. VÄLKOMMEN!**

nya boendeplattformen LocalLife kan du och dina grannar få koll på er återvinning och enkelt hantera sopsugen. Där finns även flera funktioner för att skapa en enklare vardag i kvarteret och få enkla tips för hur området kan bli mer klimatsmart.

In aktiveringskod till plattformen hittar du på vykortet du fått i brevlådan. Flera av er som bor i området har redan aktiverat er.

Har du fått din kod i brevlådan? E-posta oss på [info@locallife.se](mailto:info@locallife.se).



Projektet genomförs av KTH och LocalLife i samarbete med Stockholmshem och Envac.

**ÄS MER PÅ:  
WWW.LOCALLIFE.SE**

Stockholmshem locallife envac





# Bara stora plastförpackningar som inte får plats i sopsugen!



Här lämnar du:

- Frigolit
- Voluminösa material - som bubblefolie/skumplast
- Plastdunkar

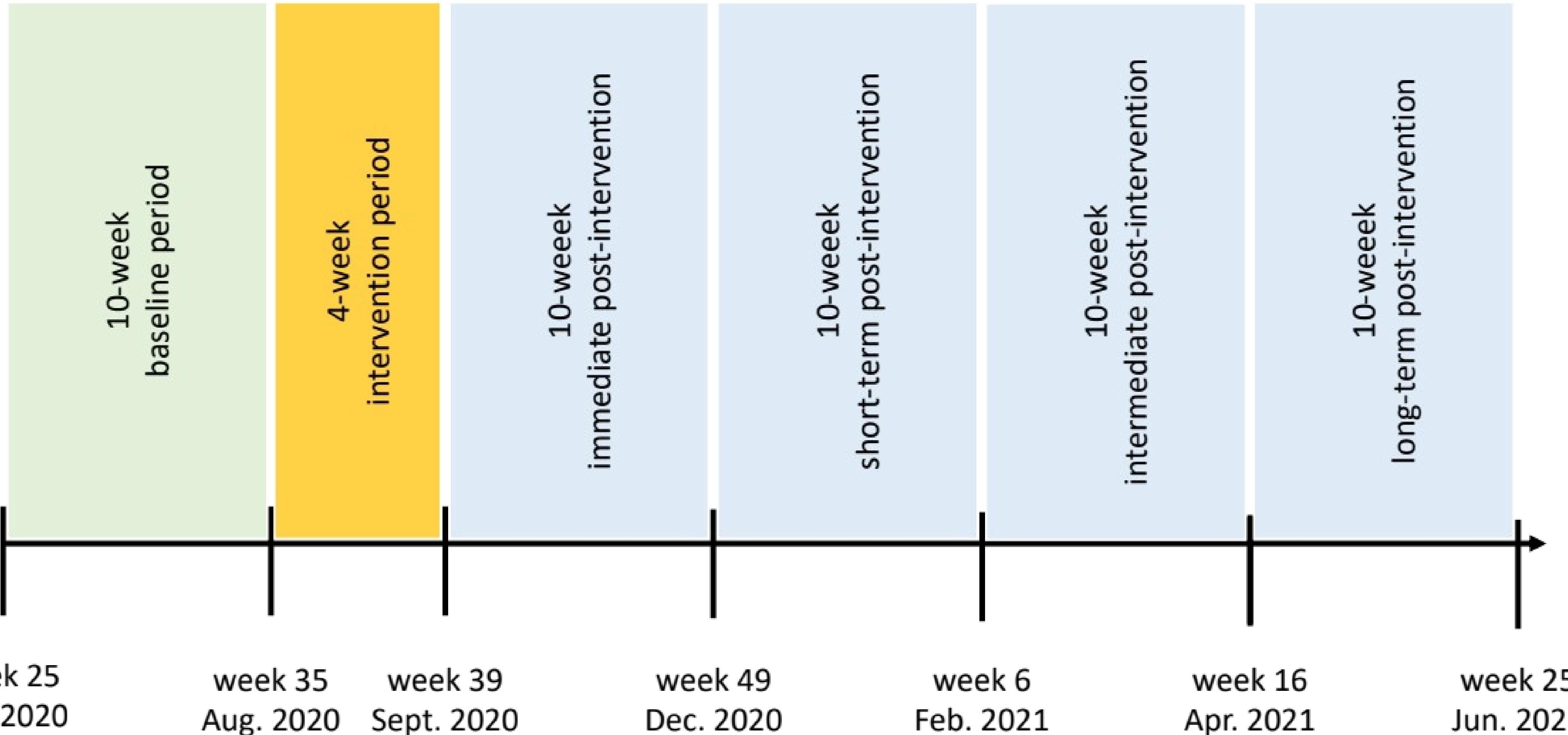
## OBS!

Alla plastförpackningar som får plats i  
sopsugen, slängs i sopsugen!

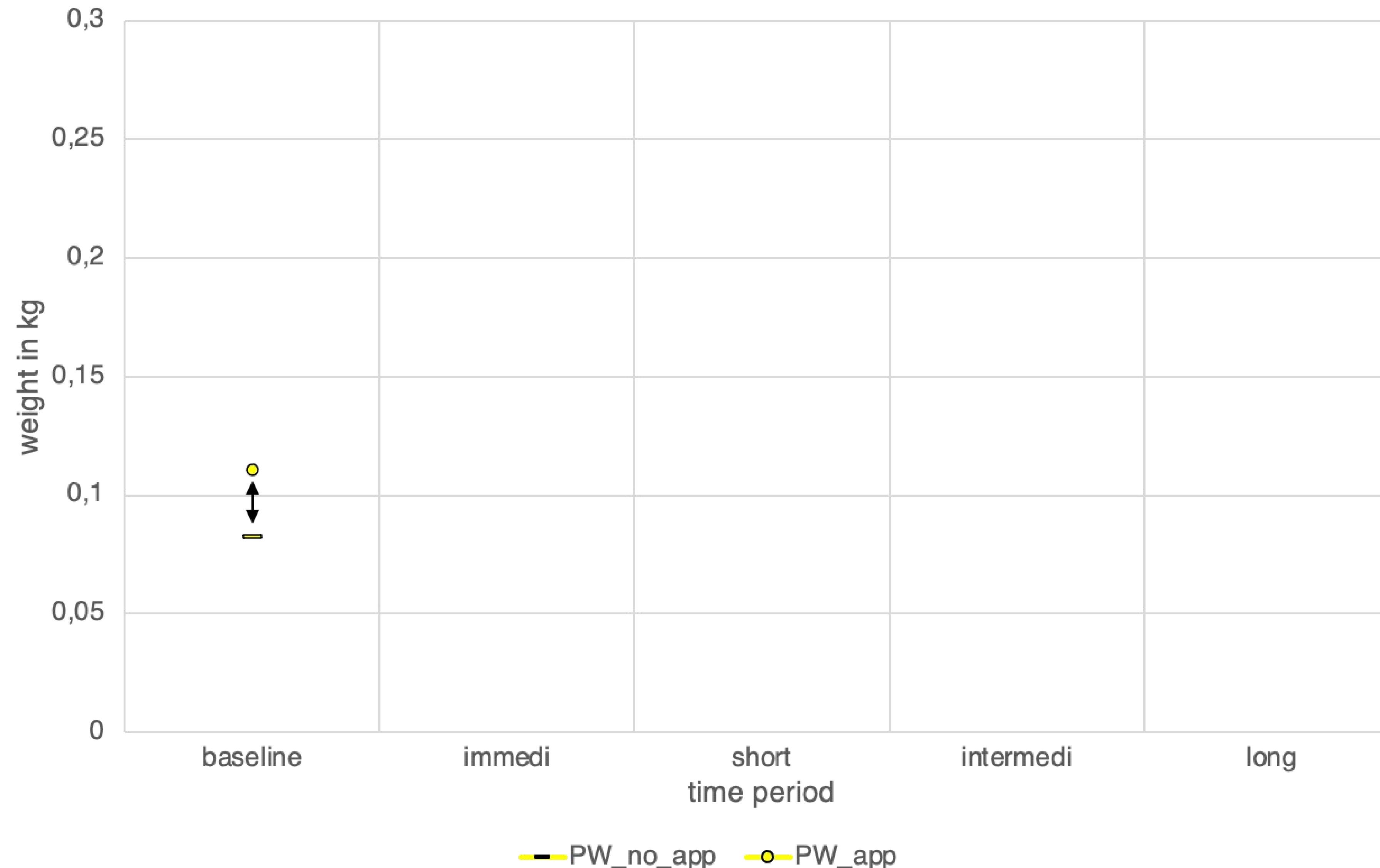
Stockholmshem



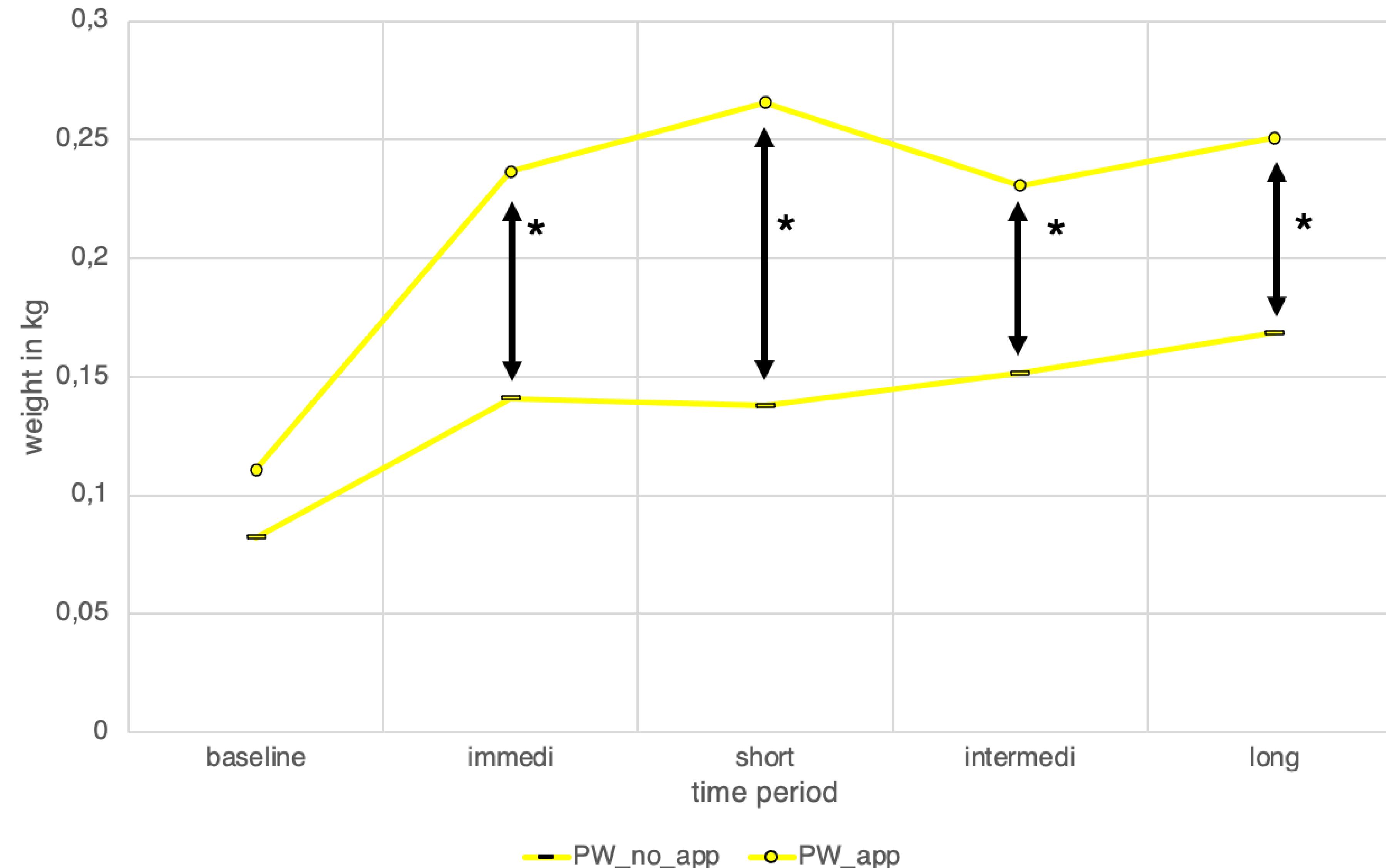
- ↗ Put up posters & distributed postcards (2 rounds)
- ↗ Ice-cream event
- ↗ App accessible for residents



## Average weekly PW per period &amp; household type

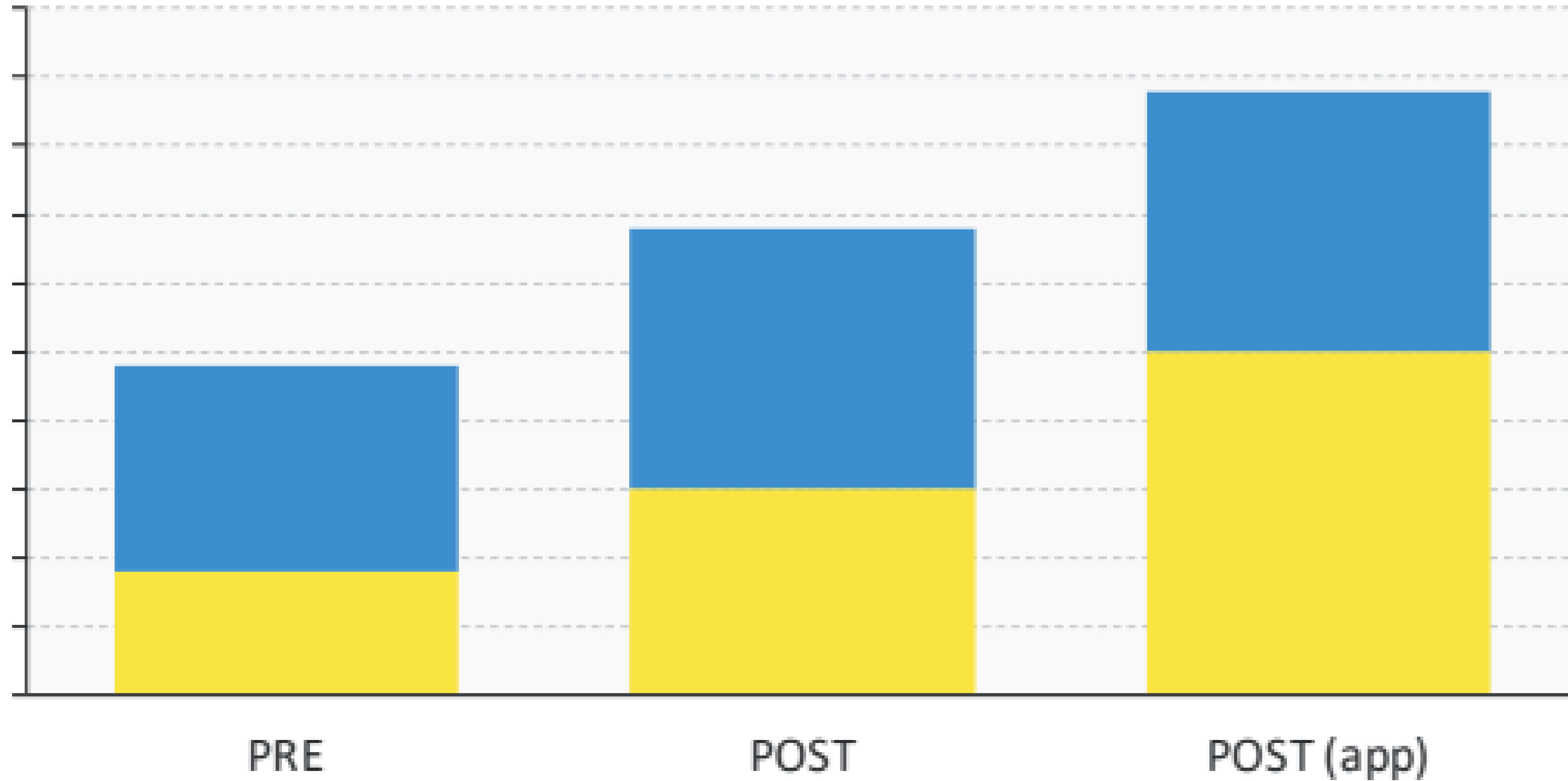


## Average weekly PW per period &amp; household type





■ Plast ■ Tidningar



# Results from pilot project



+170%  
\*

**Plastic sorting in  
vacuum system**

+26%\*

**(News)paper sorting in  
vacuum system**

-4,5%

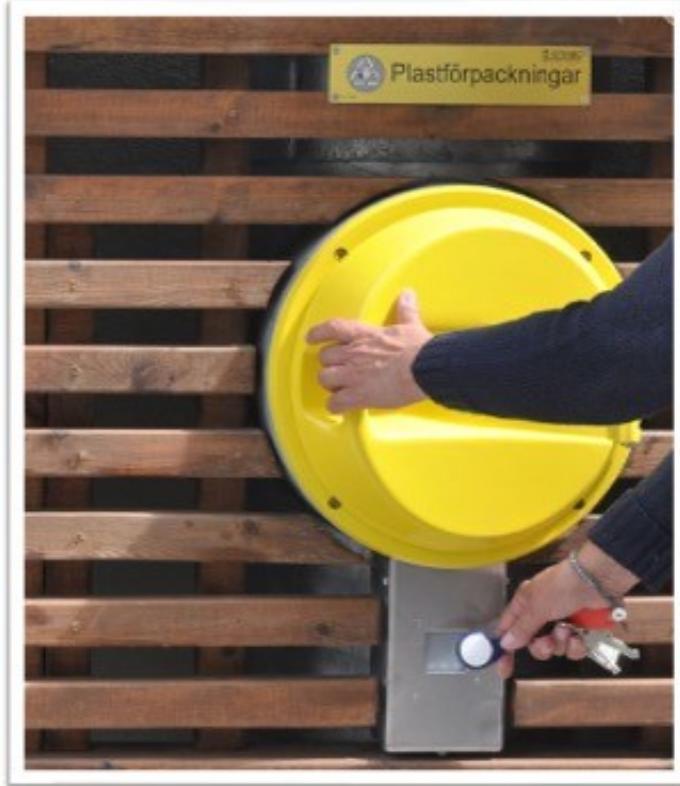
**Residual waste in  
vacuum system**

\*=statistically significant; all results show performance of app users



40% of households signed up for app

93% of app users remained registered over 12-month period



all households increased plastic & paper sorting in vacuum system

app users increased significantly more



users understand waste system and don't perceive it as a "black hole"

## Additional experiment: new & adapted waste bins

- goal: make sorting simple
- handful of households received new bins adapted to their needs + space
- resulted in  $\geq 100\%$  increased sorting



# Summary of results from pilot

- household-level RFID-data can be used to give feedback
- app was voluntarily installed by large share of users
- app users remained active for extended time period
- substantial increase of waste sorting among app users & other households
- physical interventions (recycling room + new bins at home) with large potential for improvements, especially in combination with feedback





# OUTLOOK ON FOLLOW-UP PROJECT



# Large-scale replication & continuation study

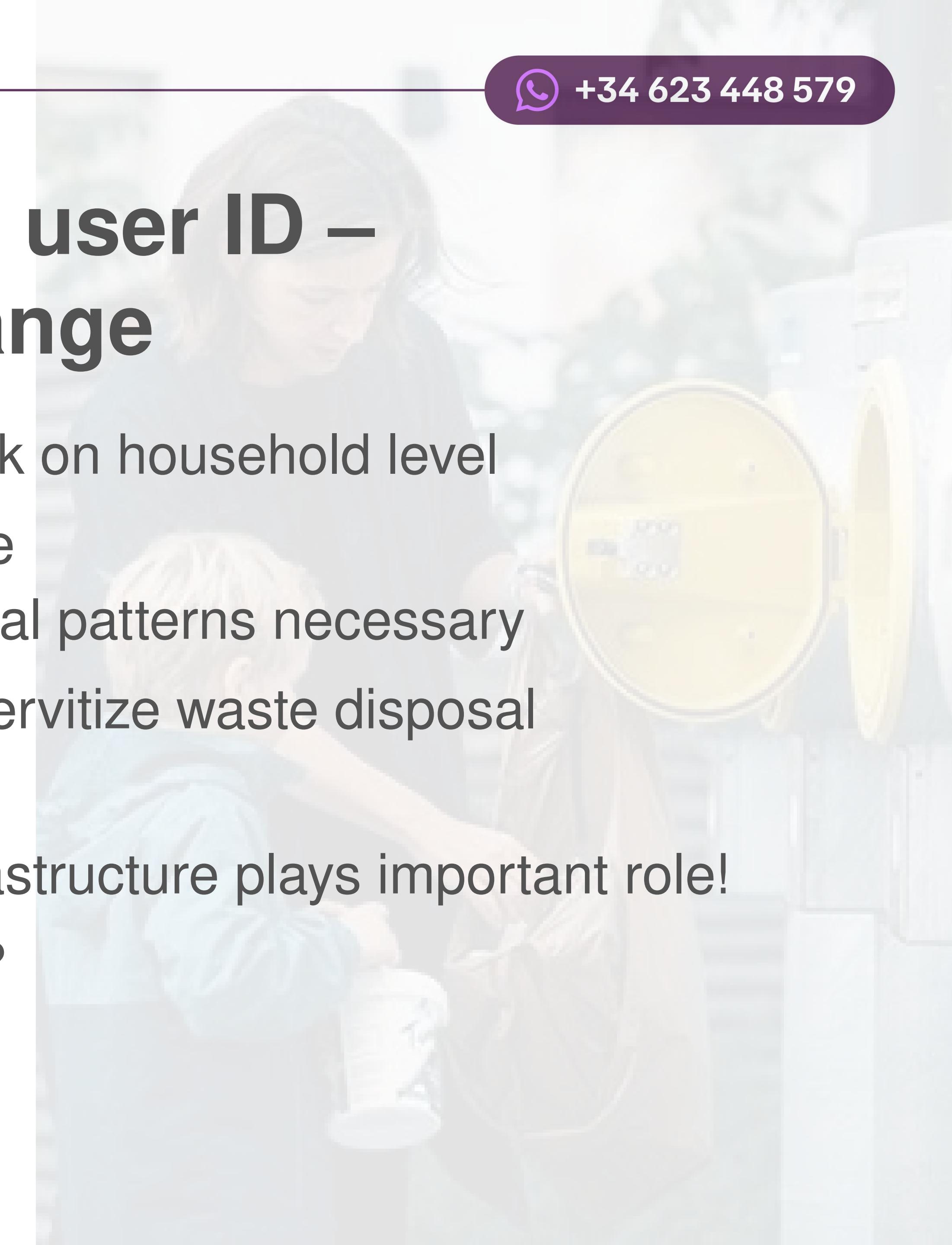
- revised app – improved layout, added "guide" function
- ca. 2500 households divided into several sub groups
  - feedback medium: physical letter vs. access to app
  - feedback specificity: household vs. building block vs. city district
  - infrastructure @home: optimized bins for home sorting vs. current system
  - infrastructure @large: optimized bins in recycling rooms vs. current system
- first results expected Q1/2024



# SUMMARY, REFLECTIONS & RECOMMENDATIONS

# Waste collection systems with user ID – opportunities for behavior change

- unprecedented opportunity to provide feedback on household level
- different starting points for behavioral influence
  - proper understanding of underlying behavioral patterns necessary
- digital tools offer broad range of functions to servitize waste disposal
  - but can be costly & difficult to develop
- holistic approach recommended: physical infrastructure plays important role!
- applicable to other contexts and data sources?
- long-term effectiveness?



# Thank you for your attention - let's be in touch!



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