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.

HENRIK SIEPELMEYER
PhD Researcher
KTH VETENSKAP OCH KONST
UiA

LARS-OLOV ANDERSSON
Technical Manager
STOCKHOLM VATTEN OCH AVFALL

ABSTRACT & OVERVIEW

+34 623 448 579

+34 623 448 579

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**: household 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

+34 623 448 579

Project partners & stakeholders

Project coordination Avfallsplan 2030

STOCKHOLM VATTEN OCH AVFALL

Financing

VINNOVA
Sveriges innovationsmyndighet

INTERNET OF THINGS SVERIGE

Building owners

Stockholmshem

FAMILJEBOSTÄDER

Brf: Björk & Plaza

Brf: Gotska Sandön

System provider

ENVAC

Research & evaluation

KTH VETENSKAP OCH KONST

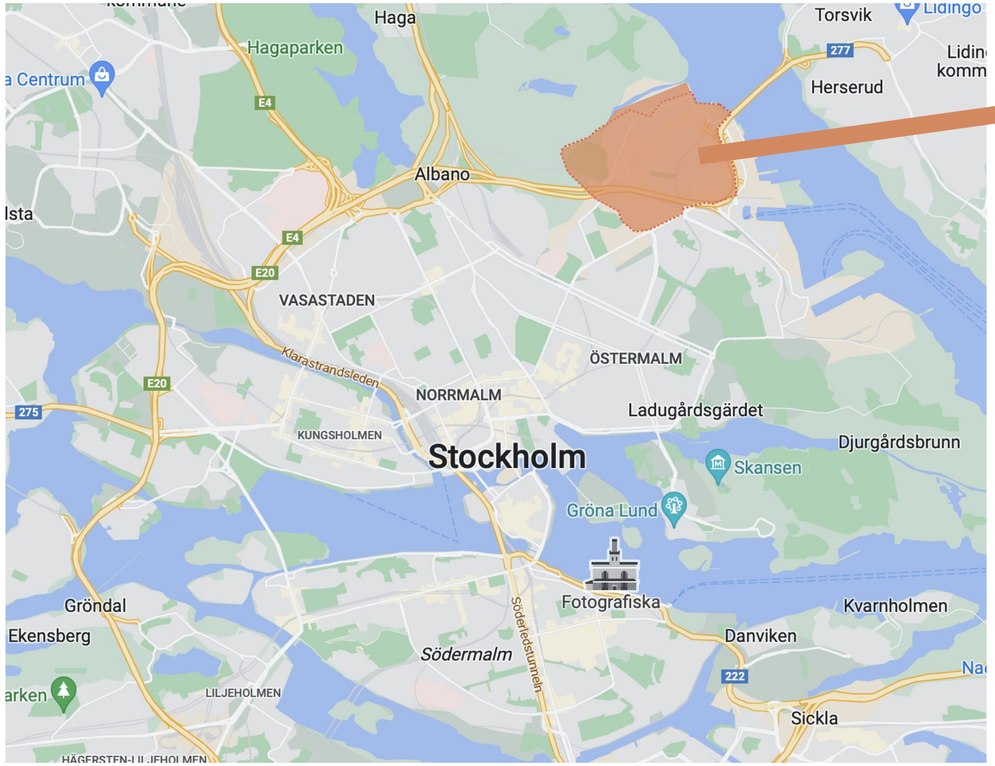
UiA

BACKGROUND & SETTING

+34 623 448 579

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+

+34 623 448 579

+34 623 448 579

Waste disposal infrastructure

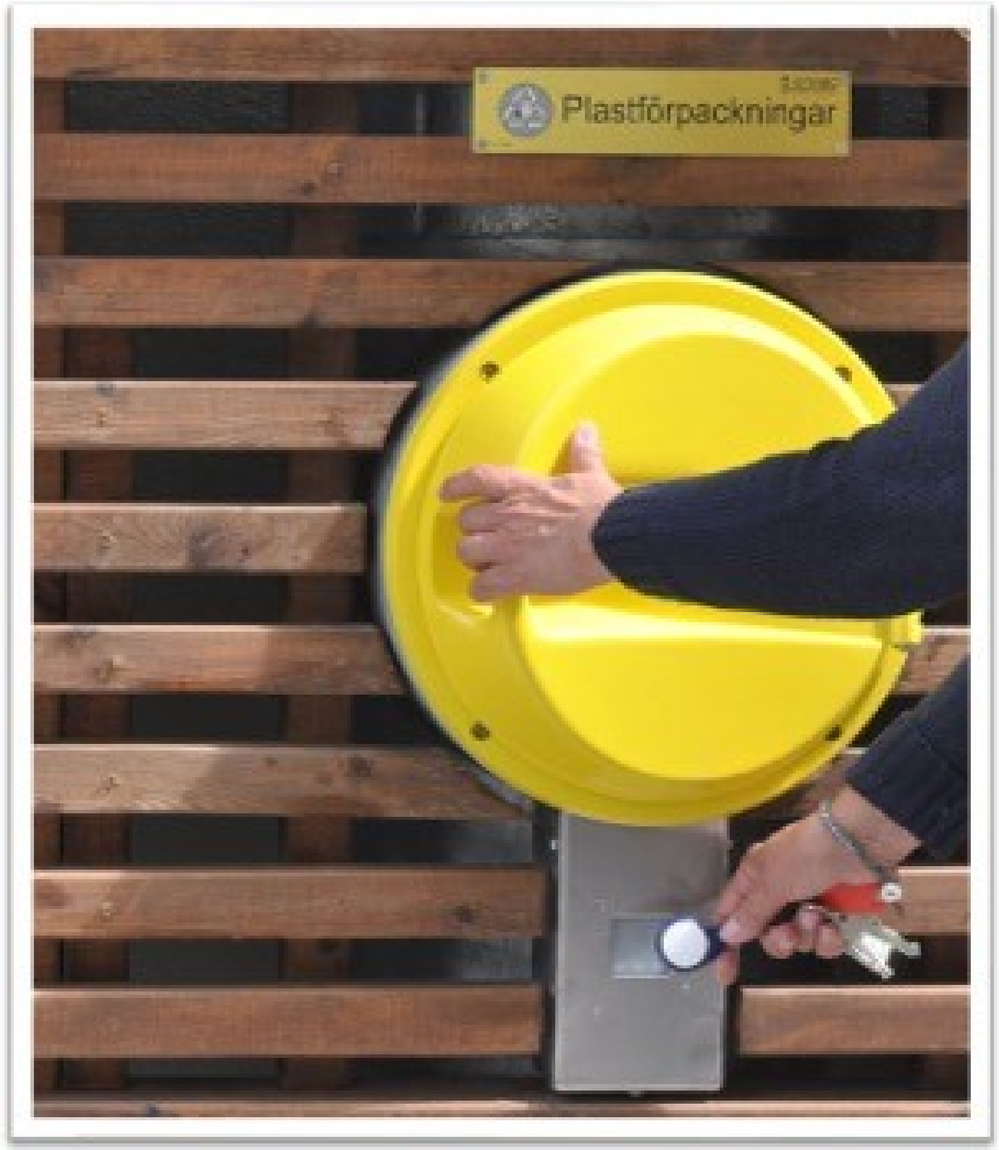
- pneumatic waste collection system for (news)paper, plastic waste, household waste & litter bins in public areas
- 400 waste inlets across properties
- 100 self-emptying litter bins in public areas
- ca. 10t waste / day collected

ENVAC

System Operator (until 2024)

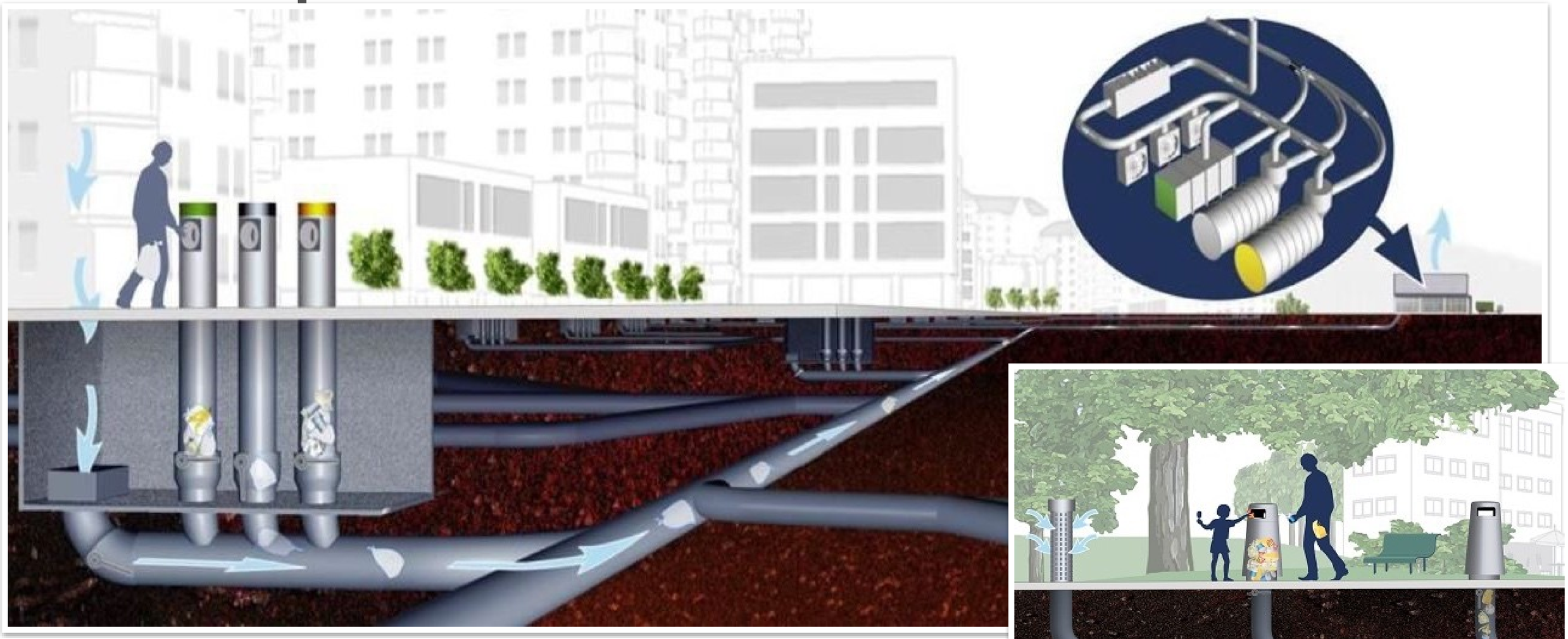
STOCKHOLM VATTEN OCH AVFALL
Stockholms stad

System Owner



+34 623 448 579

Waste disposal infrastructure



+34 623 448 579

Waste disposal infrastructure

+34 623 448 579

Waste disposal infrastructure

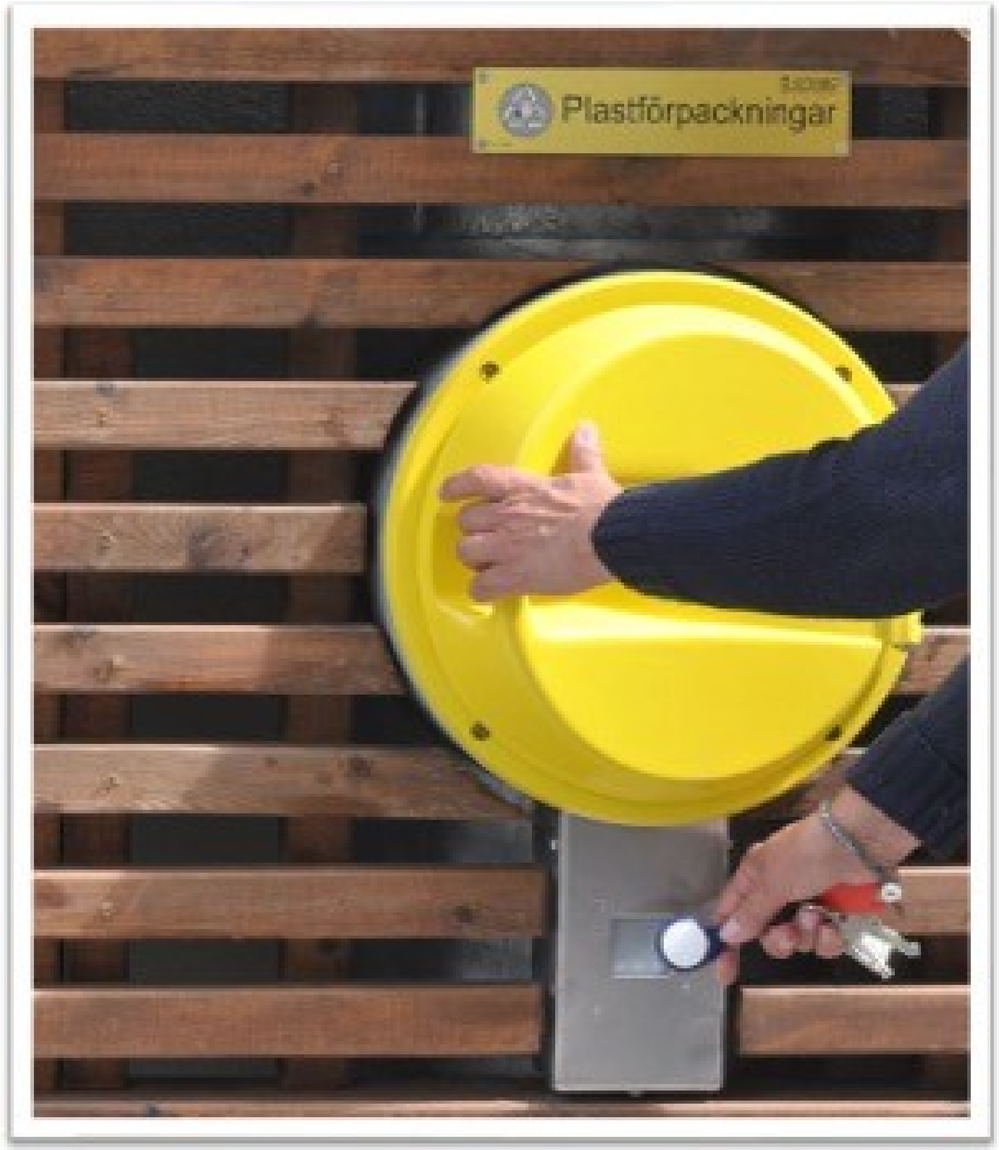
carton, paper packaging, large plastic packaging items, bulky waste, glass, metal, small electronics, light bulbs, batteries & cooking oil sorted in recycling rooms; food waste disposed through food waste grinders in kitchen sink

+34 623 448 579

Waste disposal infrastructure

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

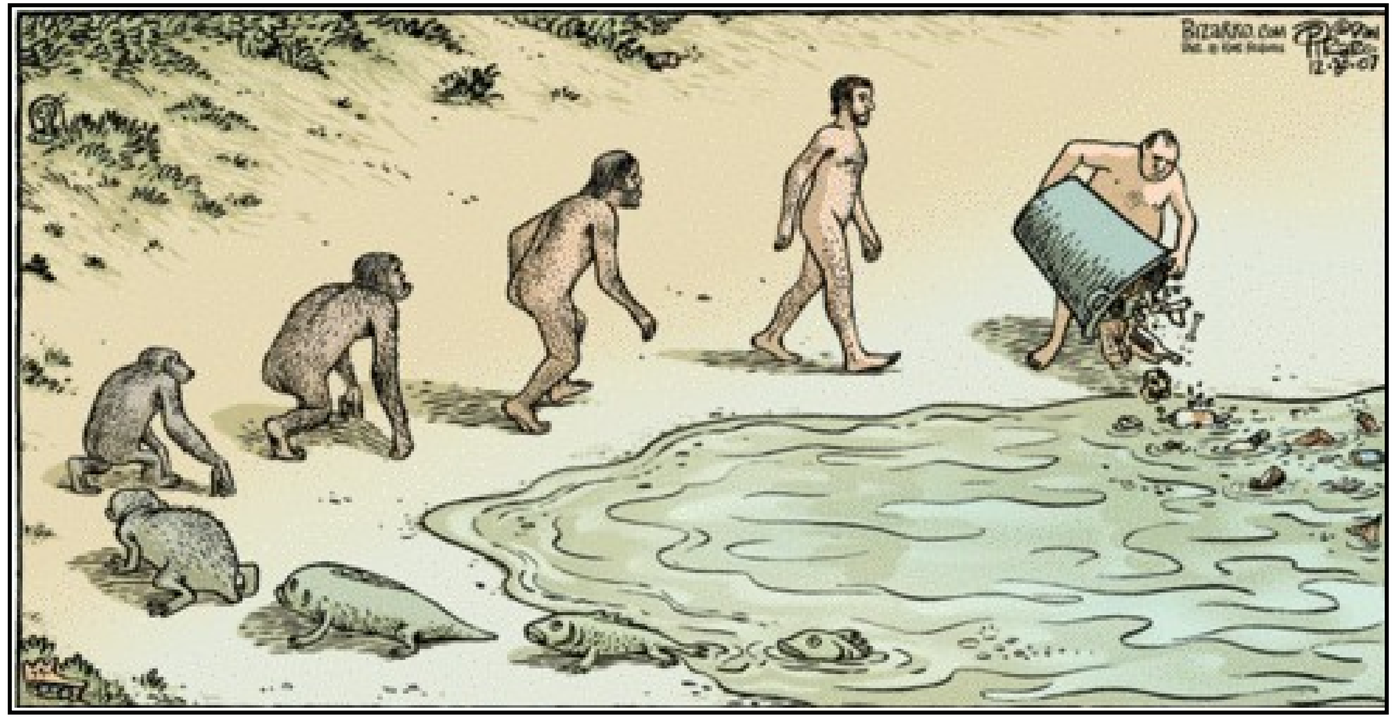
- RFID-keys enable household-level data collection
- opening frequencies for all fractions
- integrated scales for household waste in pilot area
- weight estimates for other fractions in pneumatic waste system



+34 623 448 579

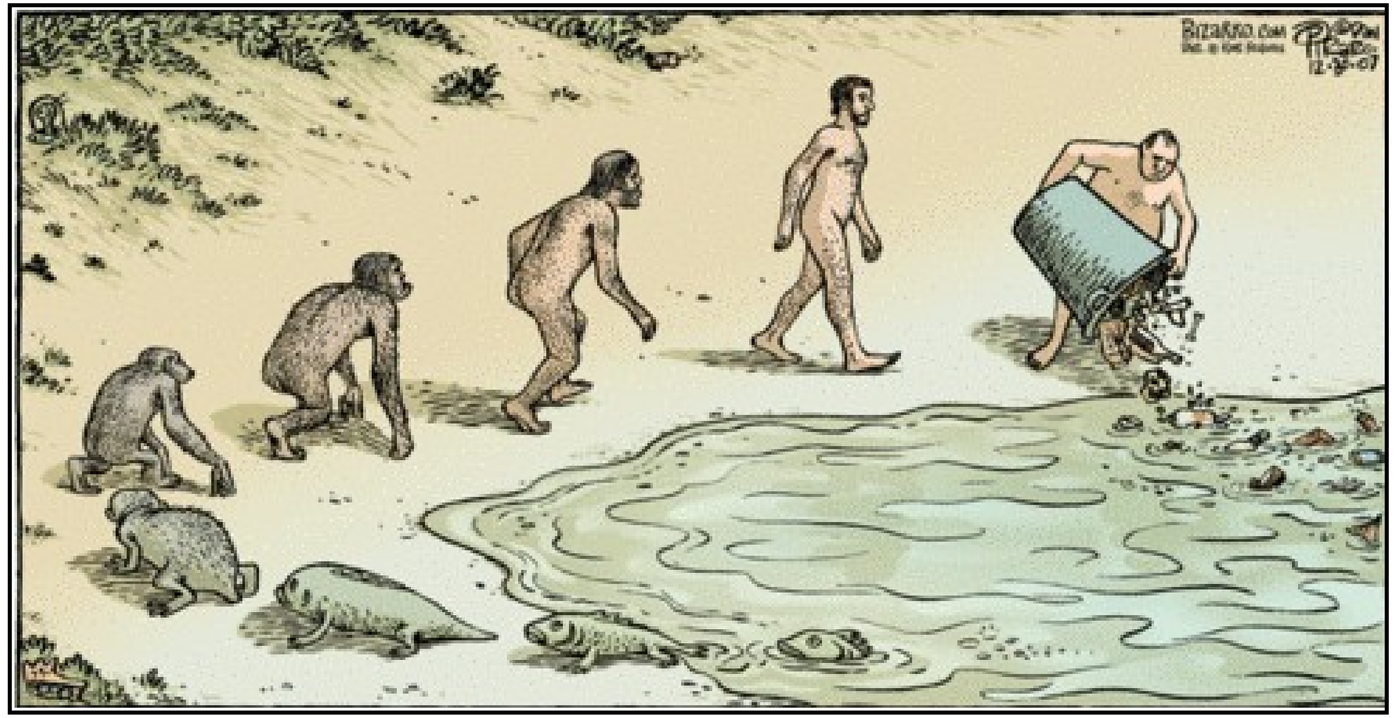
BEHAVIORAL INTERVENTION & PILOT PROJECT

wasteinprogress



© 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

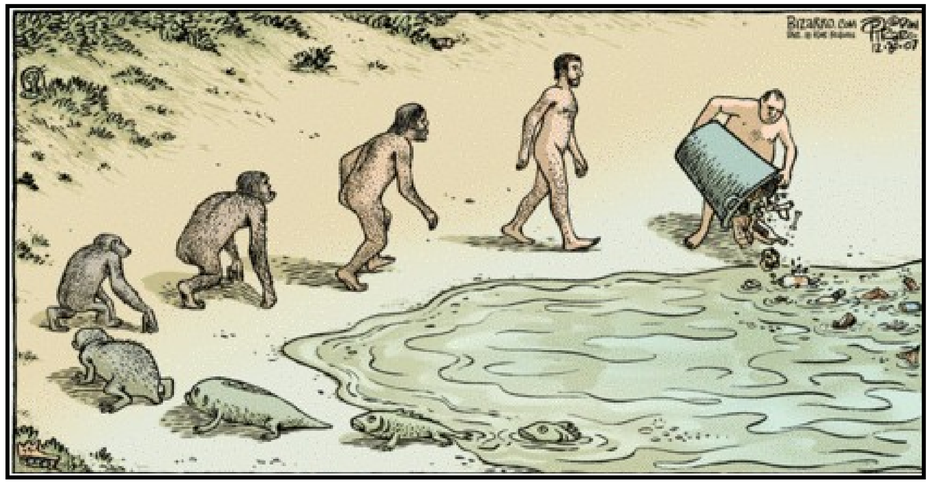
System 2

—rational—

5%

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

wasteinprogress



System 1

—intuitive & instinctive—

95%

quick
parallel
automatic
effortless
daily decisions
habits
learns slow

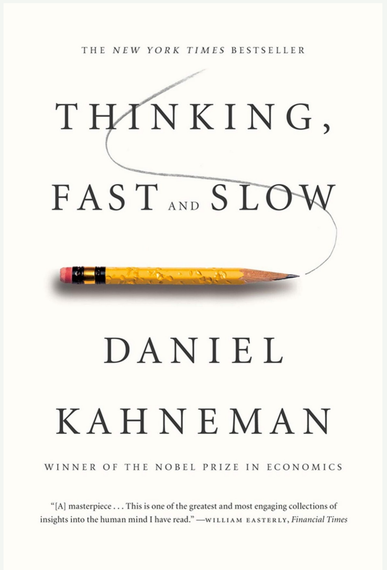
System 2

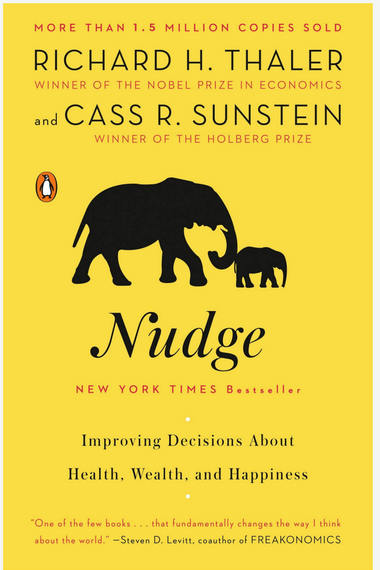
—rational—

5%

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

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





+34 623 448 579

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”



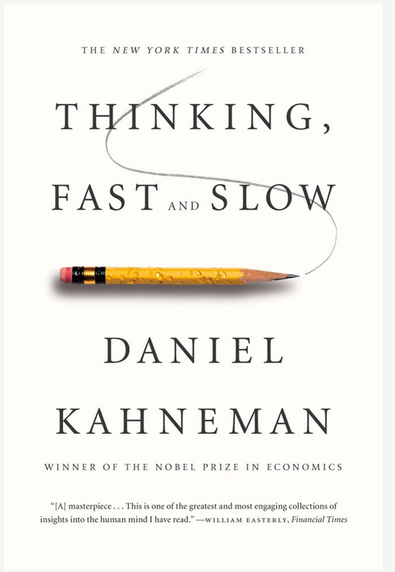


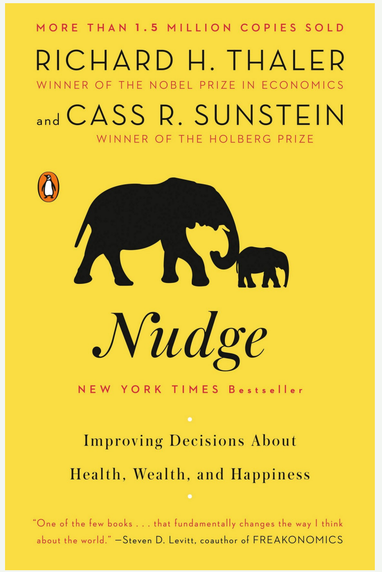
wasteinprogress

Potential strategies to overcome barriers & influence household waste behaviors:

1. Feedback & social norms

2. Make the desired behavior easy





+34 623 448 579

Why feedback & social norms?

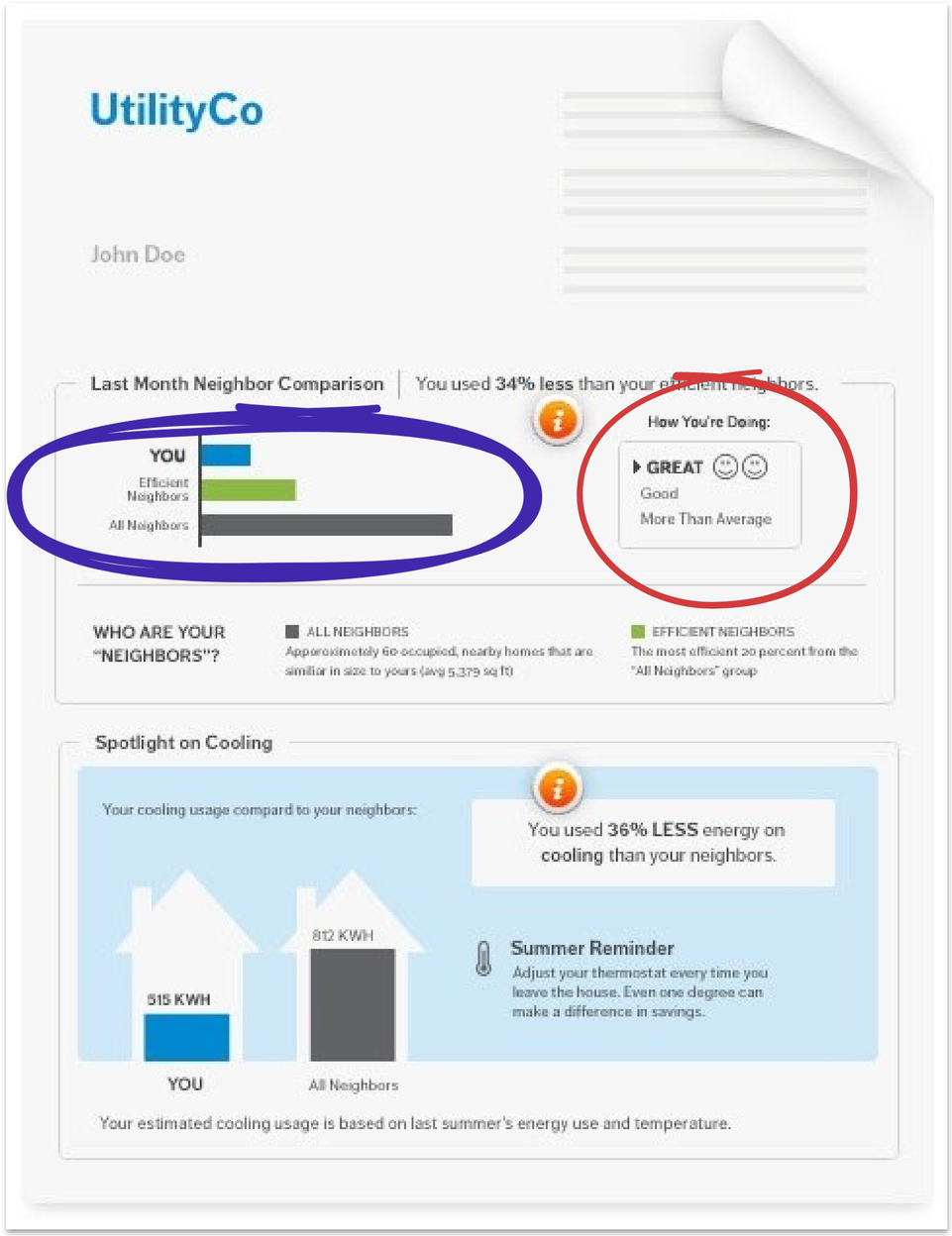
- lack of natural feedback loops (Princen 2001)

- humans are social animals:
  - we follow the behavior of others
  - we care about what others think of us

- 2 types of norms:
  - **de**scriptive norms
  - **pre**scriptive 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

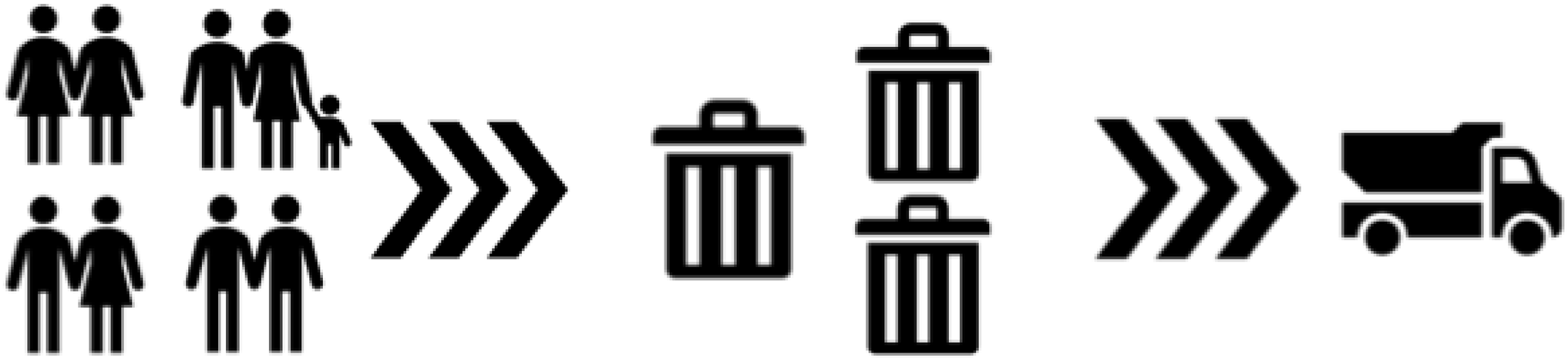
- clear & congruent instructions
- sufficient preparation – waste bags, bins, …
- require as little effort as possible

→ 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)

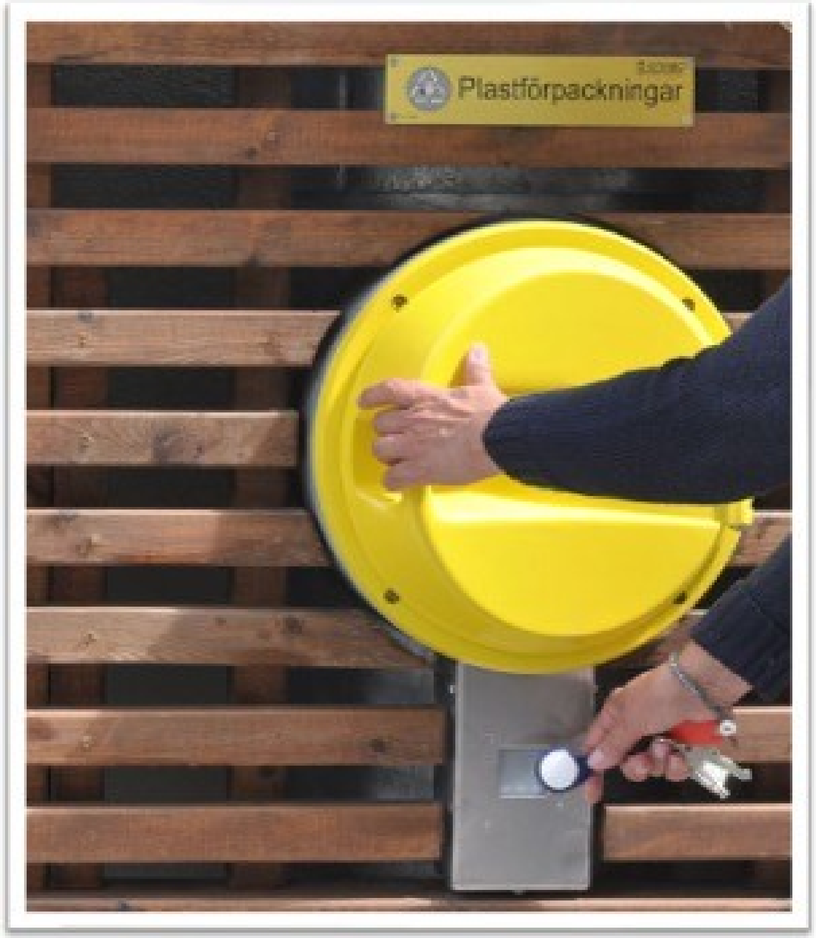
+34 623 448 579

Making the desired behavior easy

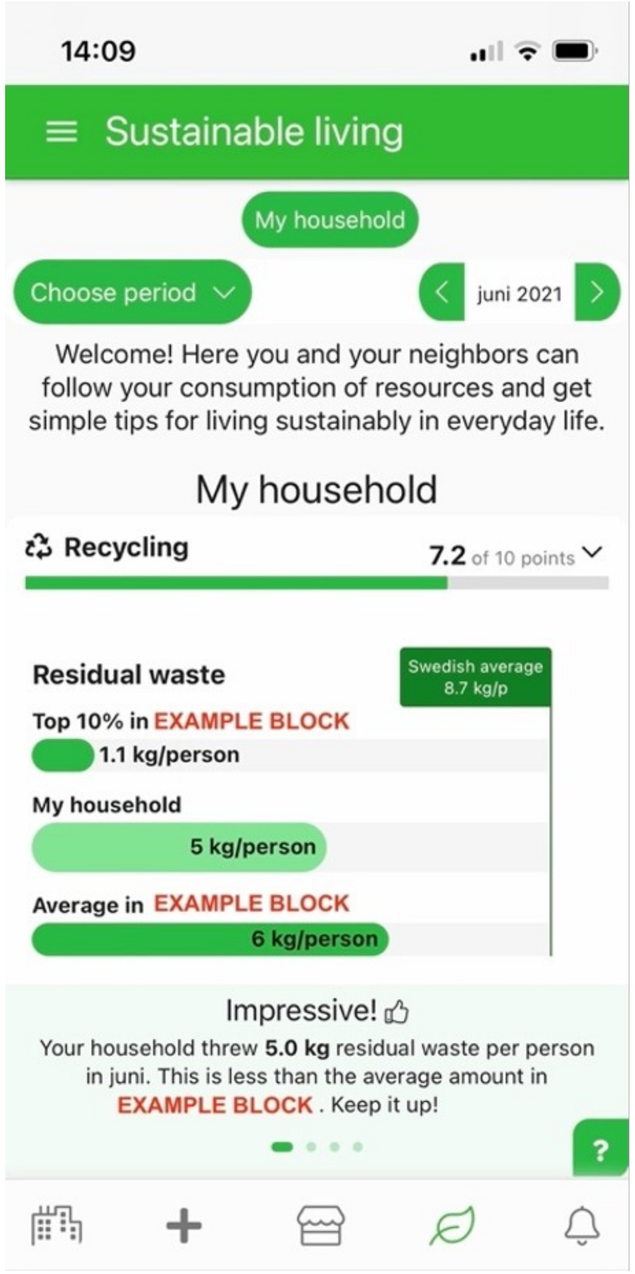
+34 623 448 579

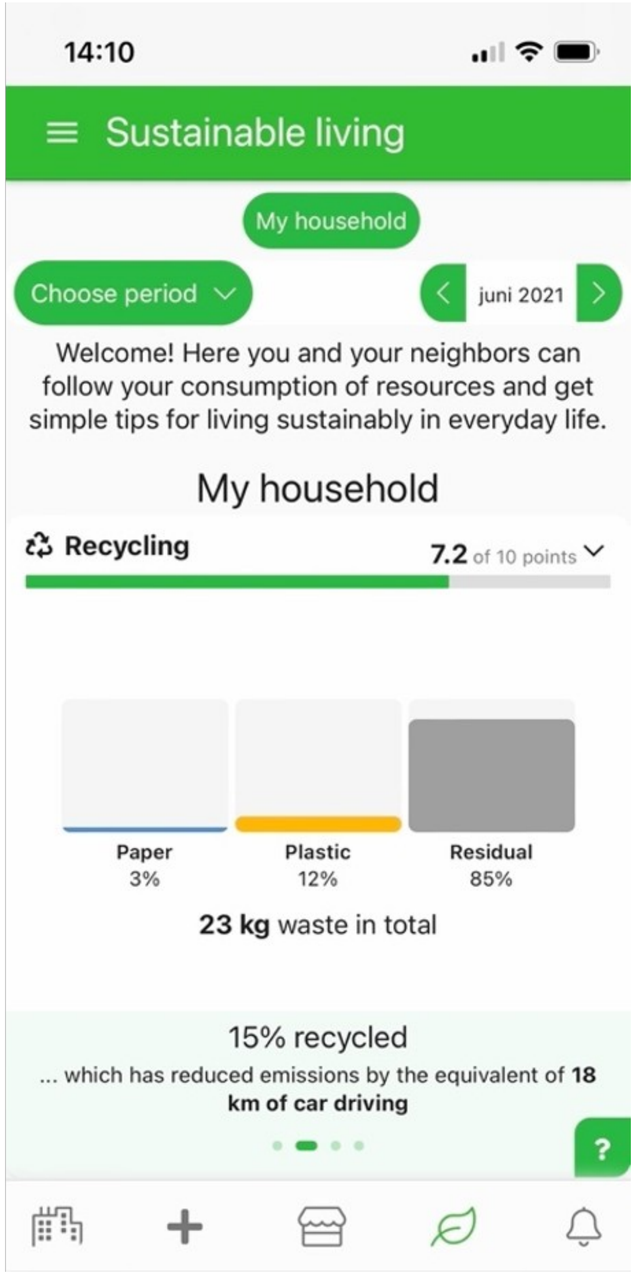


+34 623 448 579



+34 623 448 579



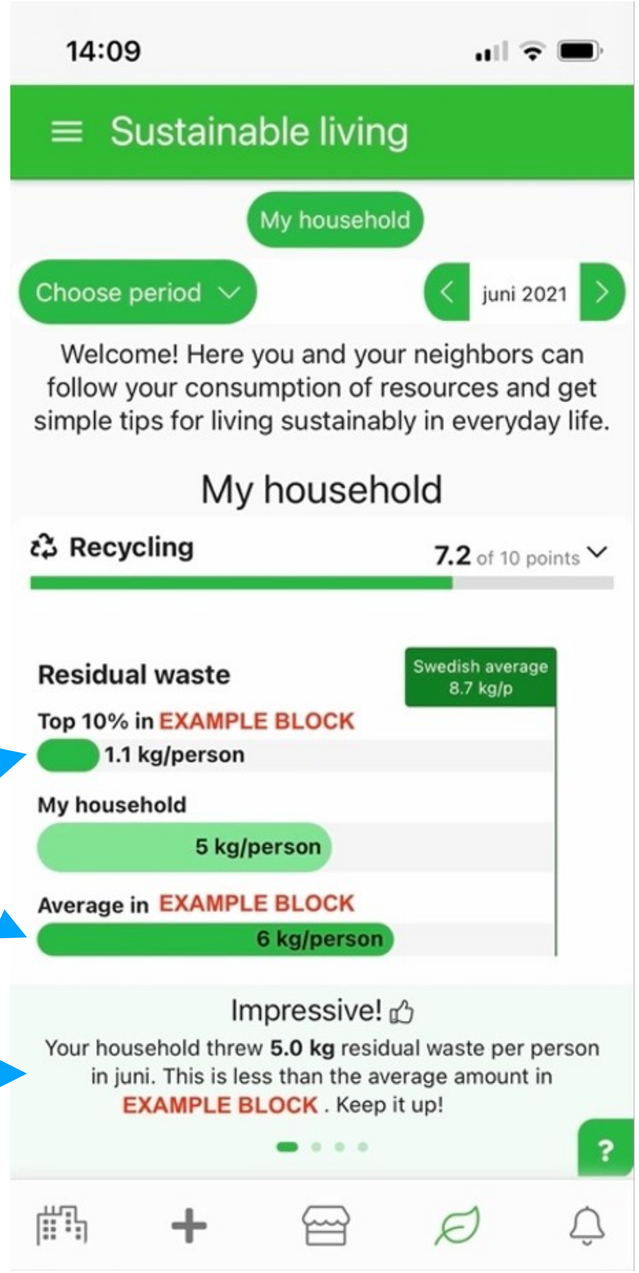


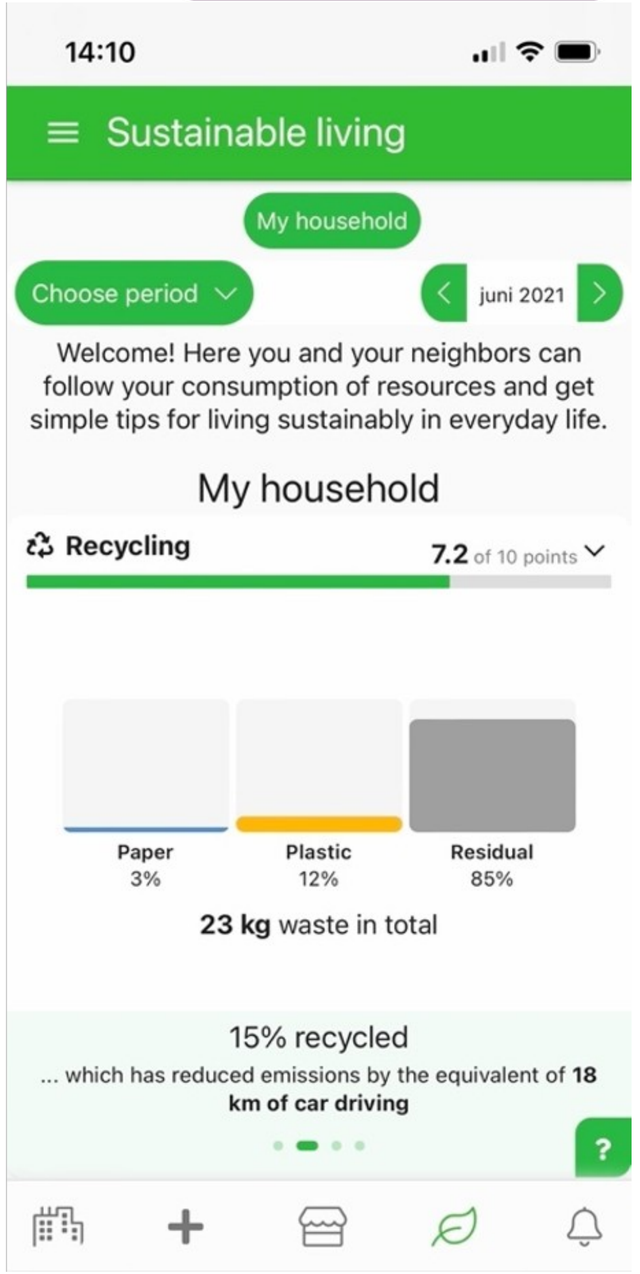
+34 623 448 579

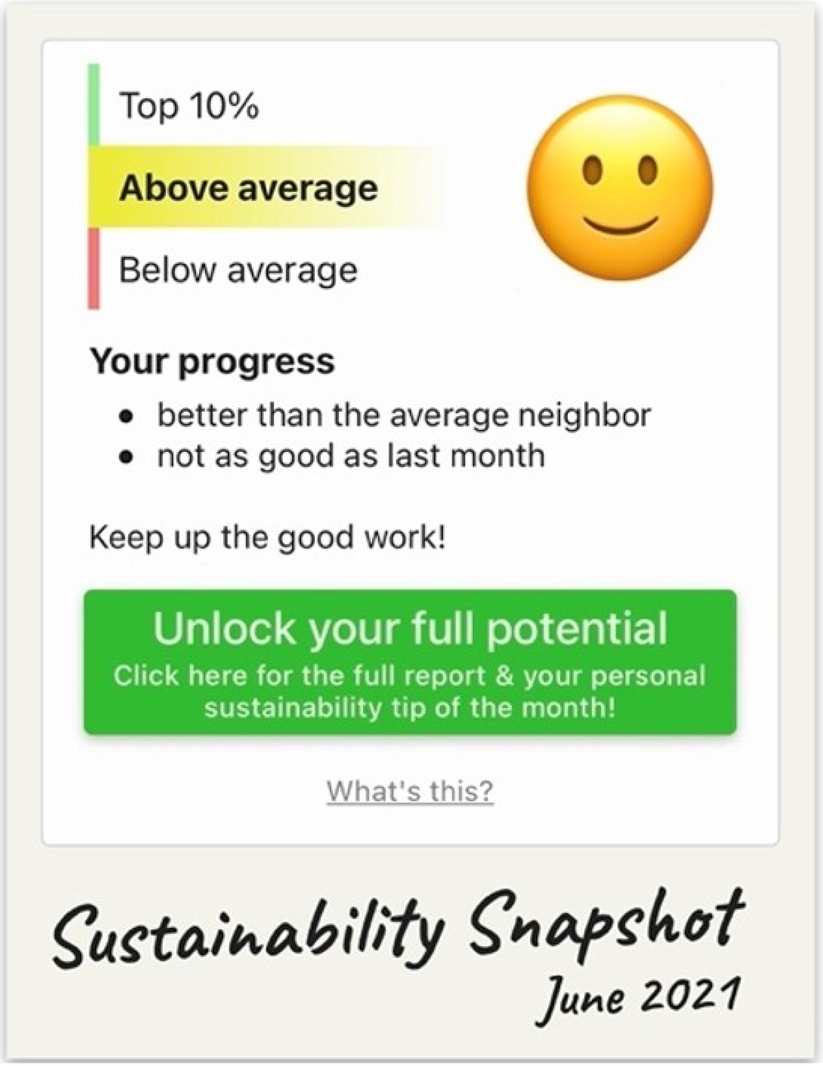
Important to combine **de**scriptive & **pre**scriptive norm to avoid rebound effects.

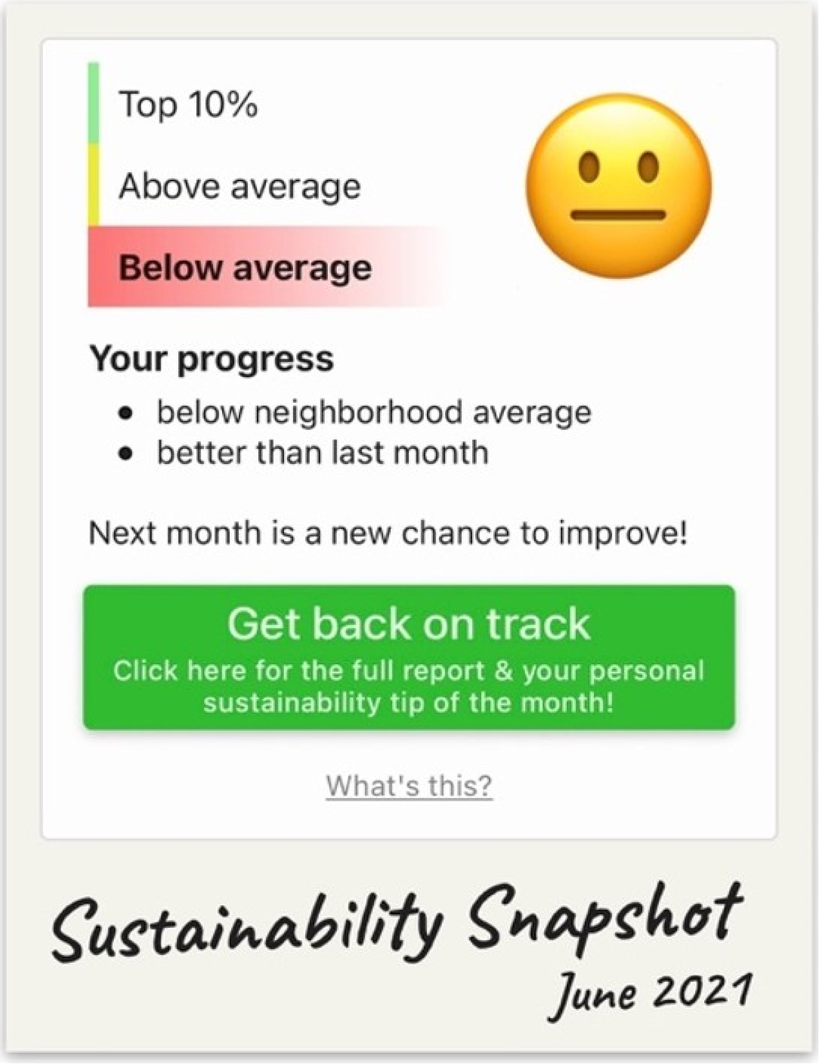
Descriptive norm:
Comparison to neighbors with lowest amount of household waste & average neighbors

Prescriptive norm:
Overall evaluation: good / ok / bad ?



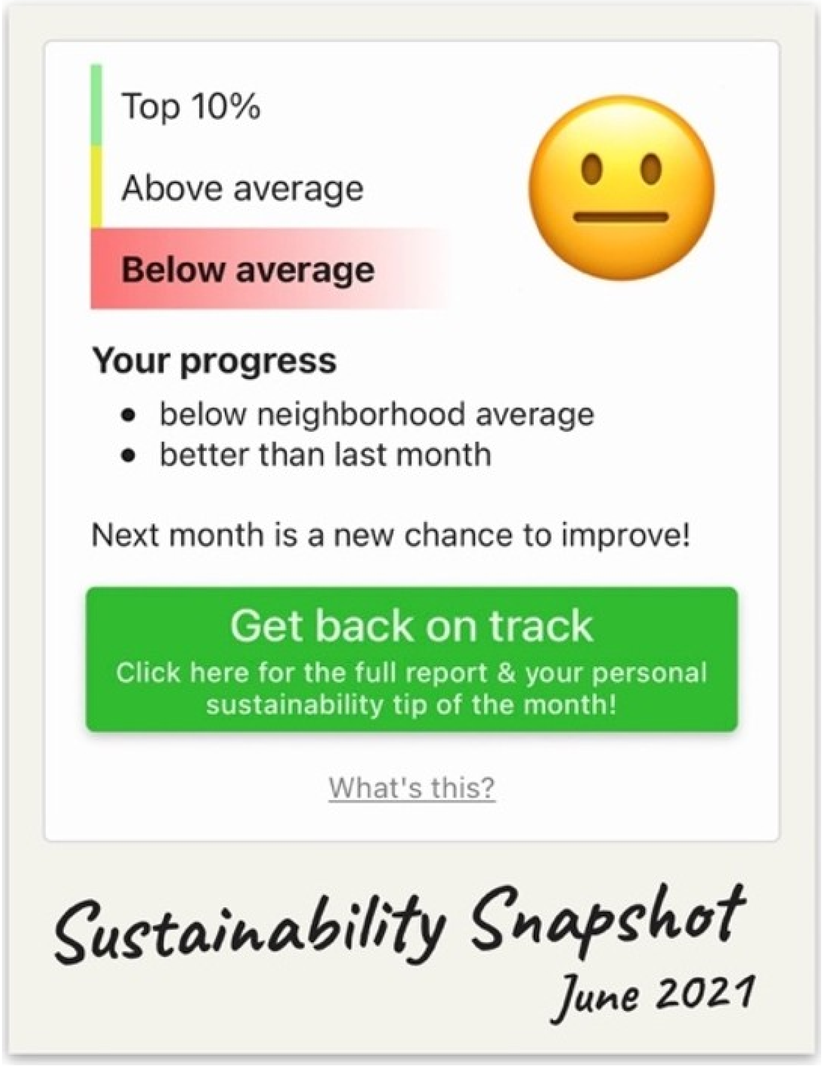



Top 10%
Above average
Below average
Your progress
better than the average neighbor
not as good as last month
Keep up the good work!
Unlock your full potential
Click here for the full report & your personal sustainability tip of the month!
What's this?
Sustainability Snapshot
June 2021

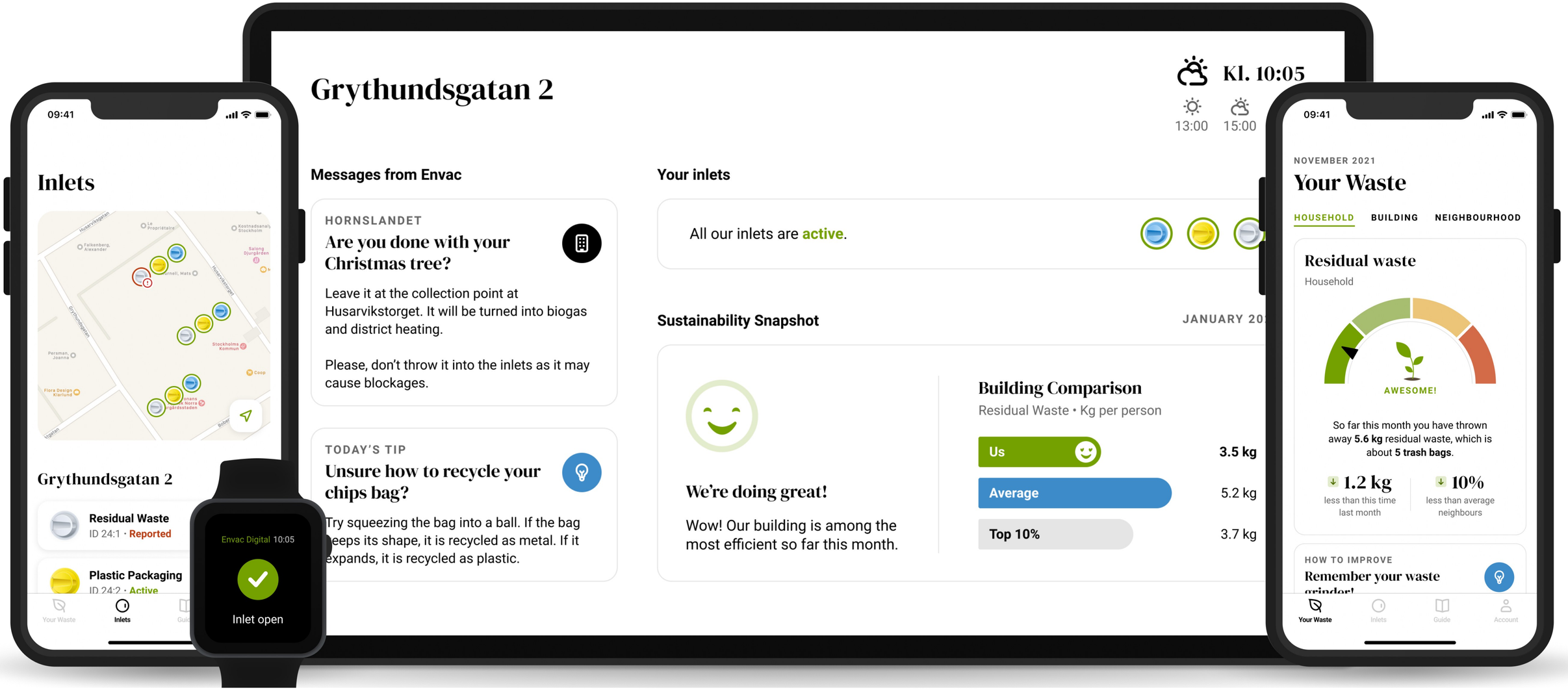

Top 10%
Above average
Below average
Your progress
below neighborhood average
better than last month
Next month is a new chance to improve!
Get back on track
Click here for the full report & your personal sustainability tip of the month!
What's this?
Sustainability Snapshot
June 2021

Prescriptive norm

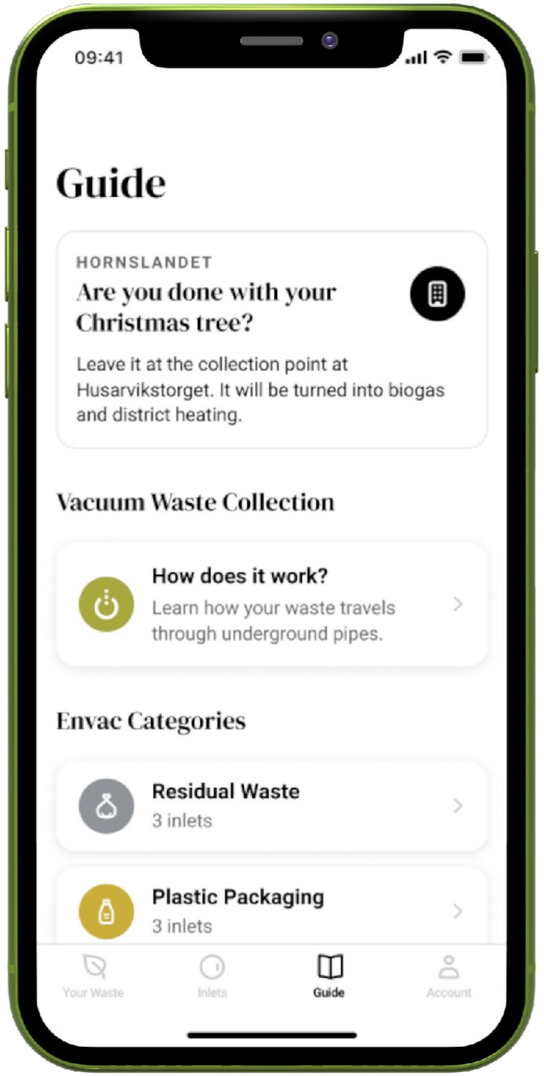
Descriptive norm

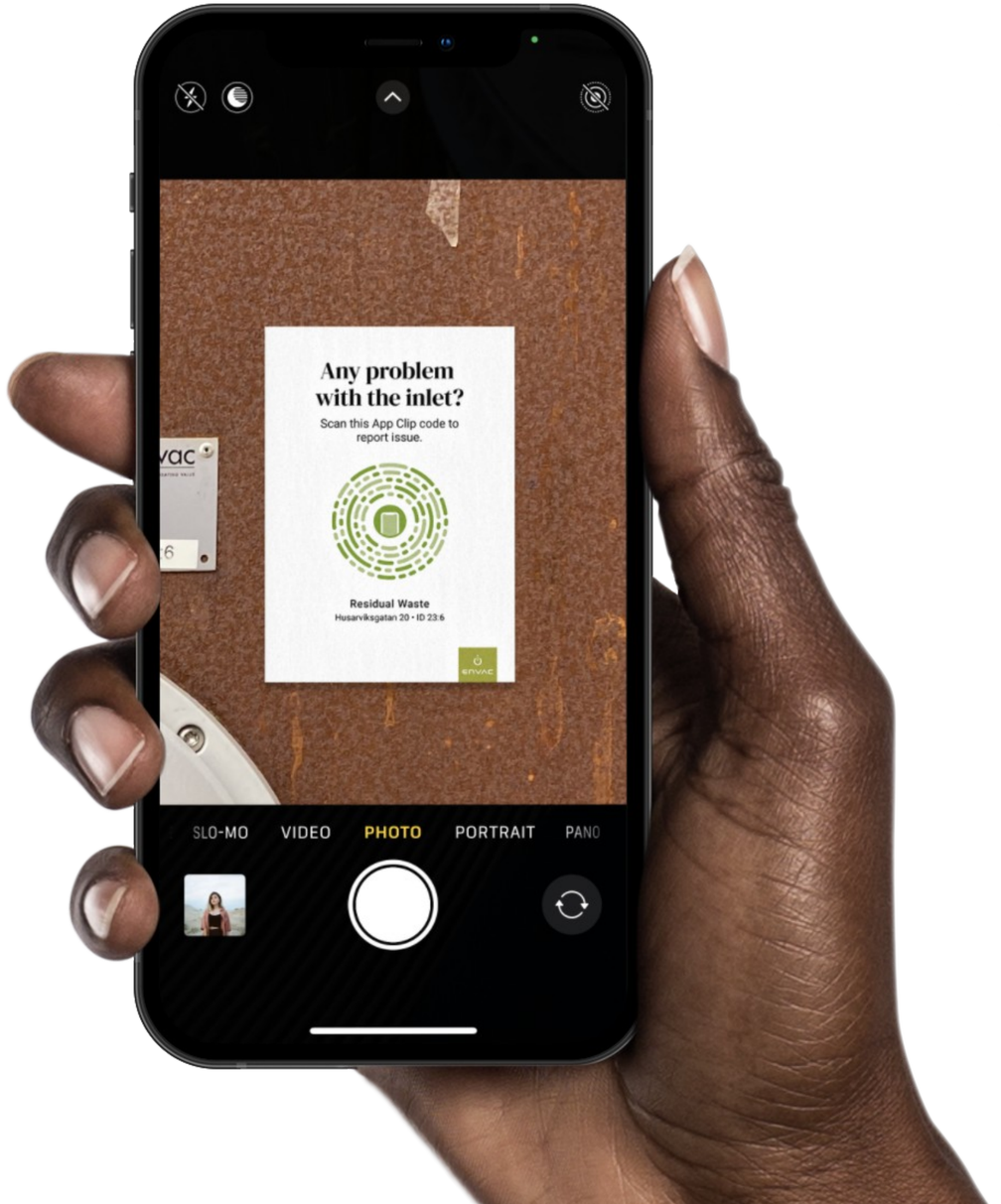


+34 623 448 579



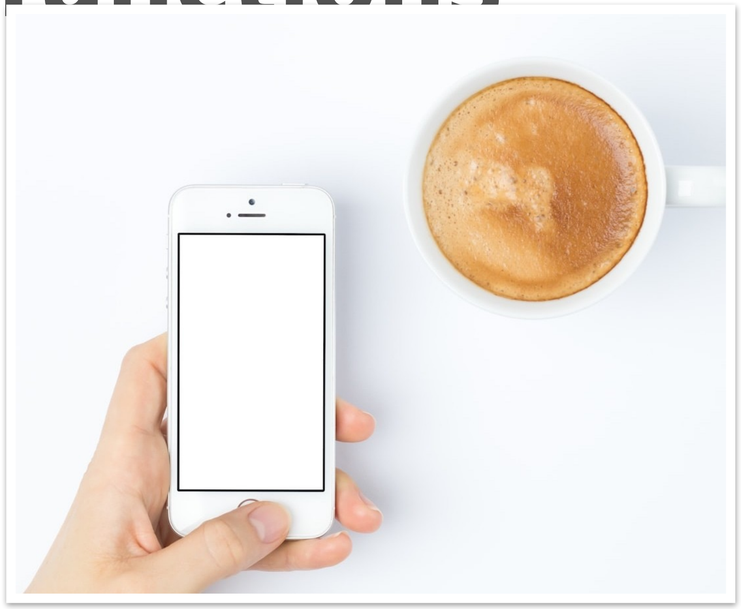
+34 623 448 579





+34 623 448 579

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

+34 623 448 579

Number of households

152

Share of app users

40%

Time period

06/2020 – 06/2021

Project focus

increase plastic sorting

Waste fractions

UiA

KTH VETENSKAP OCH KONST

Stockholmshem

+34 623 448 579

wasteinprogress

+34 623 448 579

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

SMÅ PLAST-FÖRPACKNINGAR?

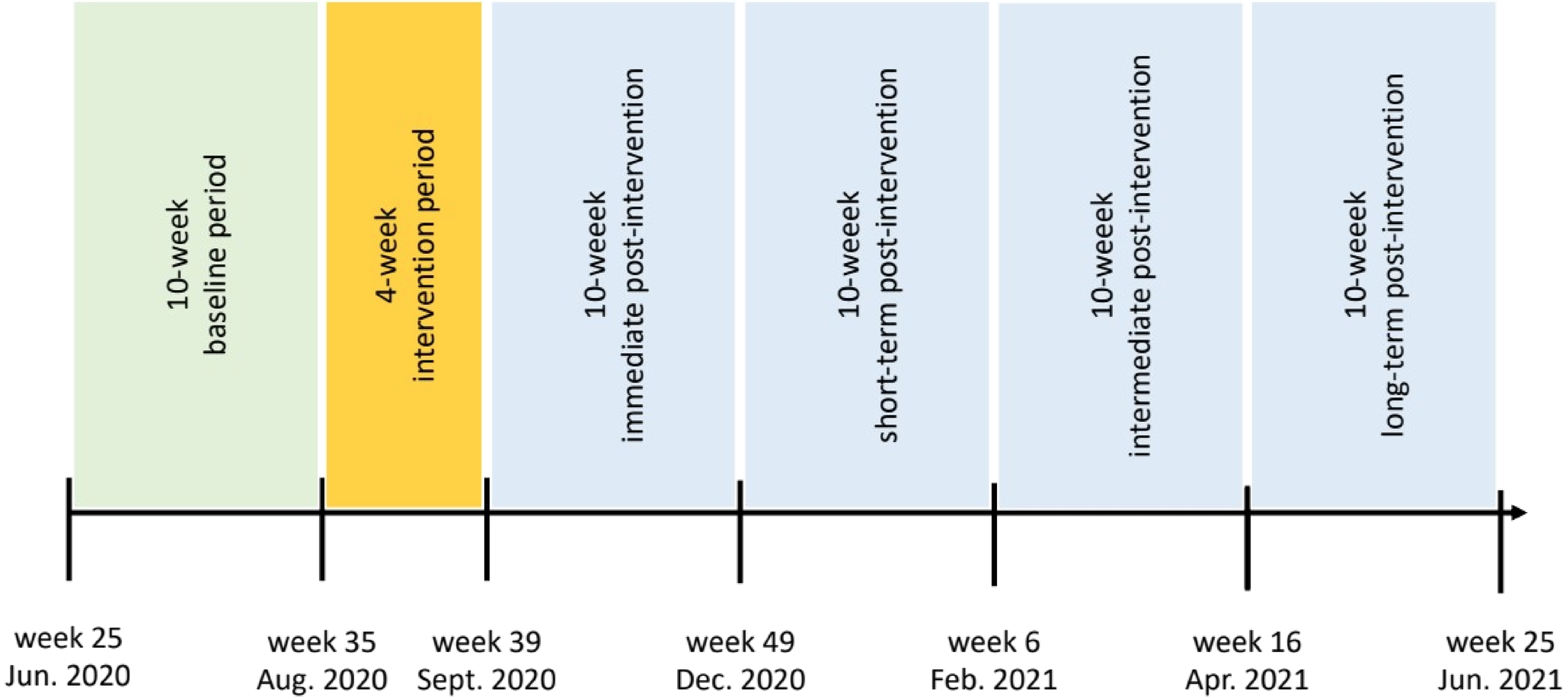
DE SLÄNGS NU I SOPSUGEN!

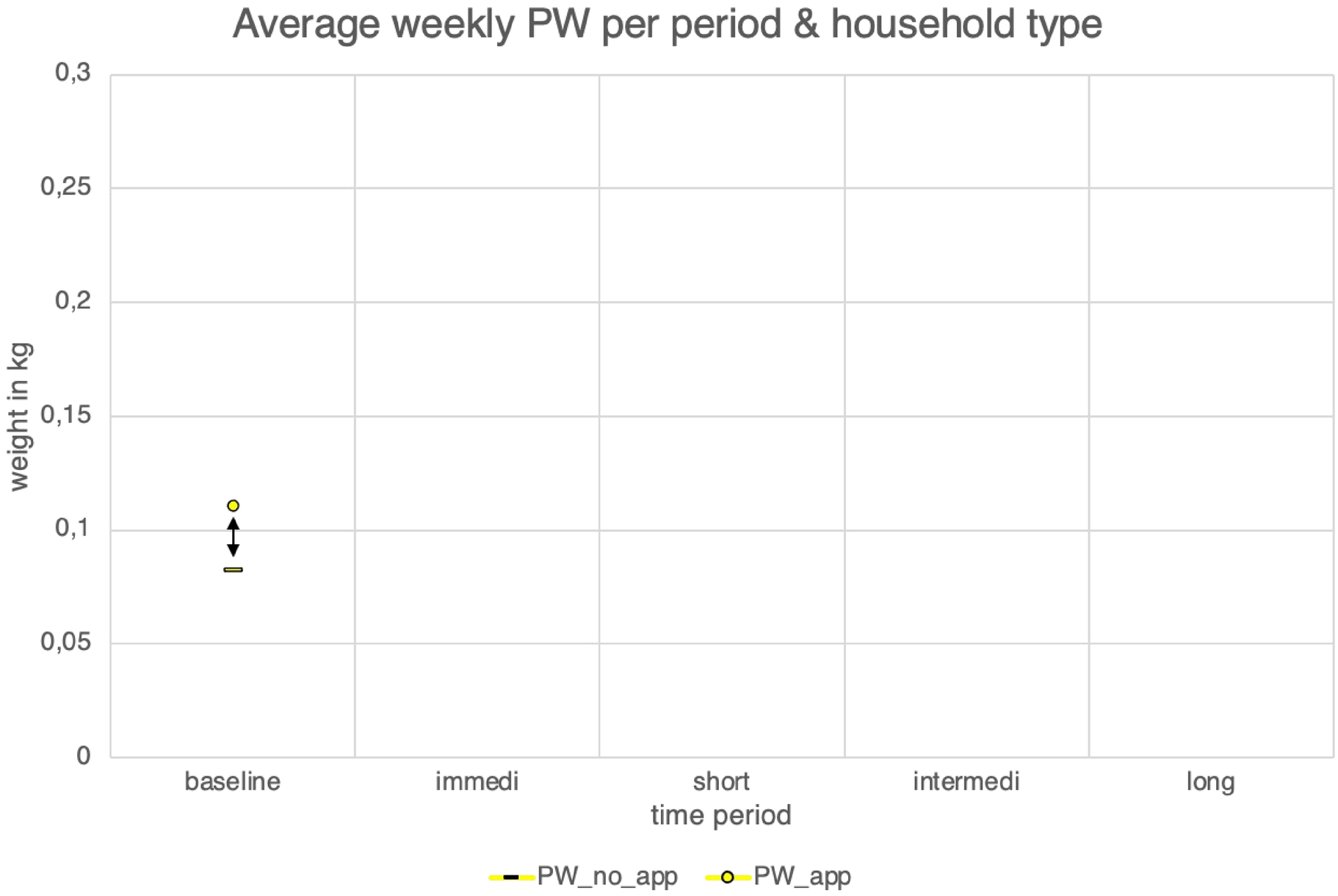
För mindre lukt i miljörummet och färre sopbilar i kvarteret.

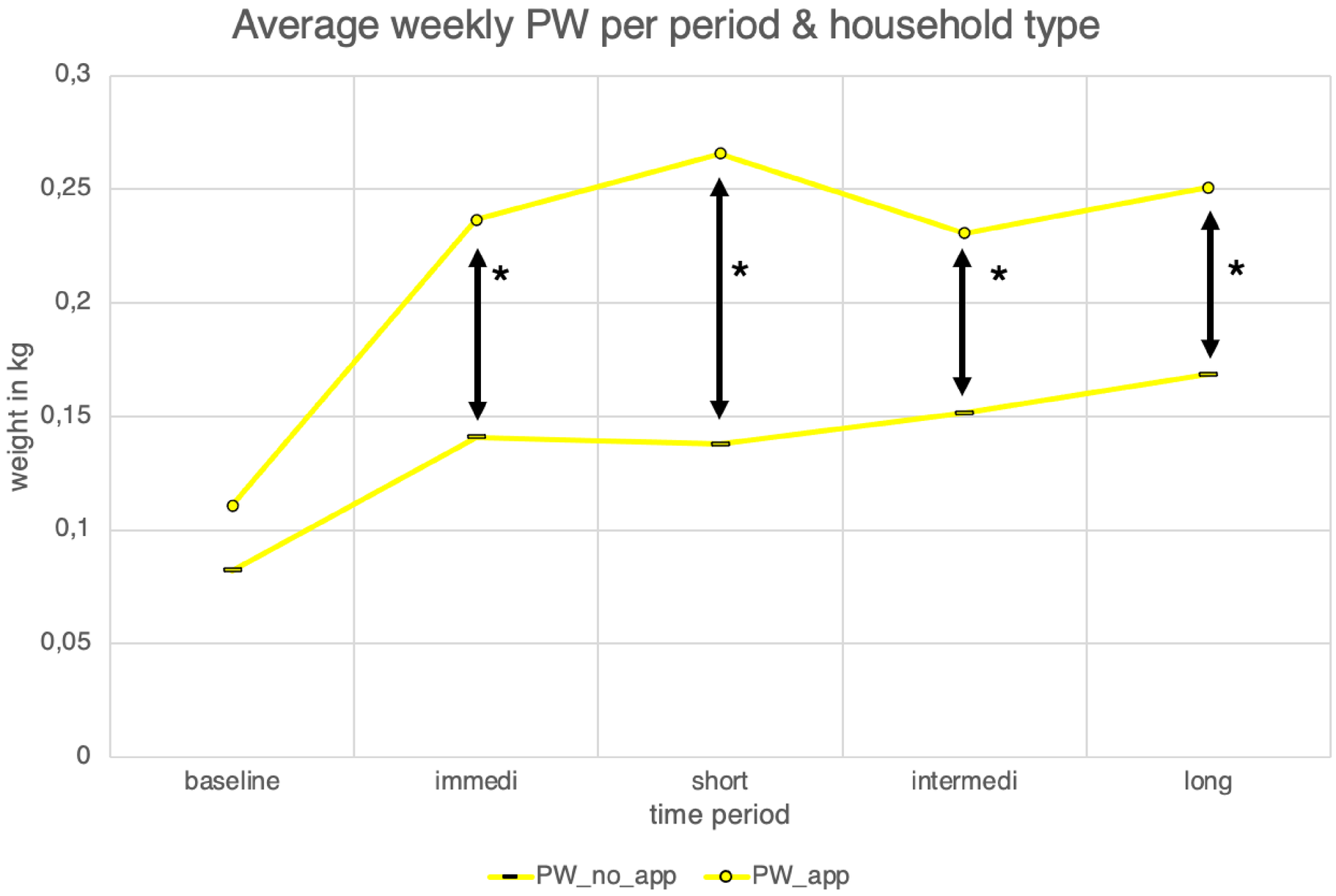
↱ Put up posters & distributed postcards (2 rounds)

↱ Ice-cream event

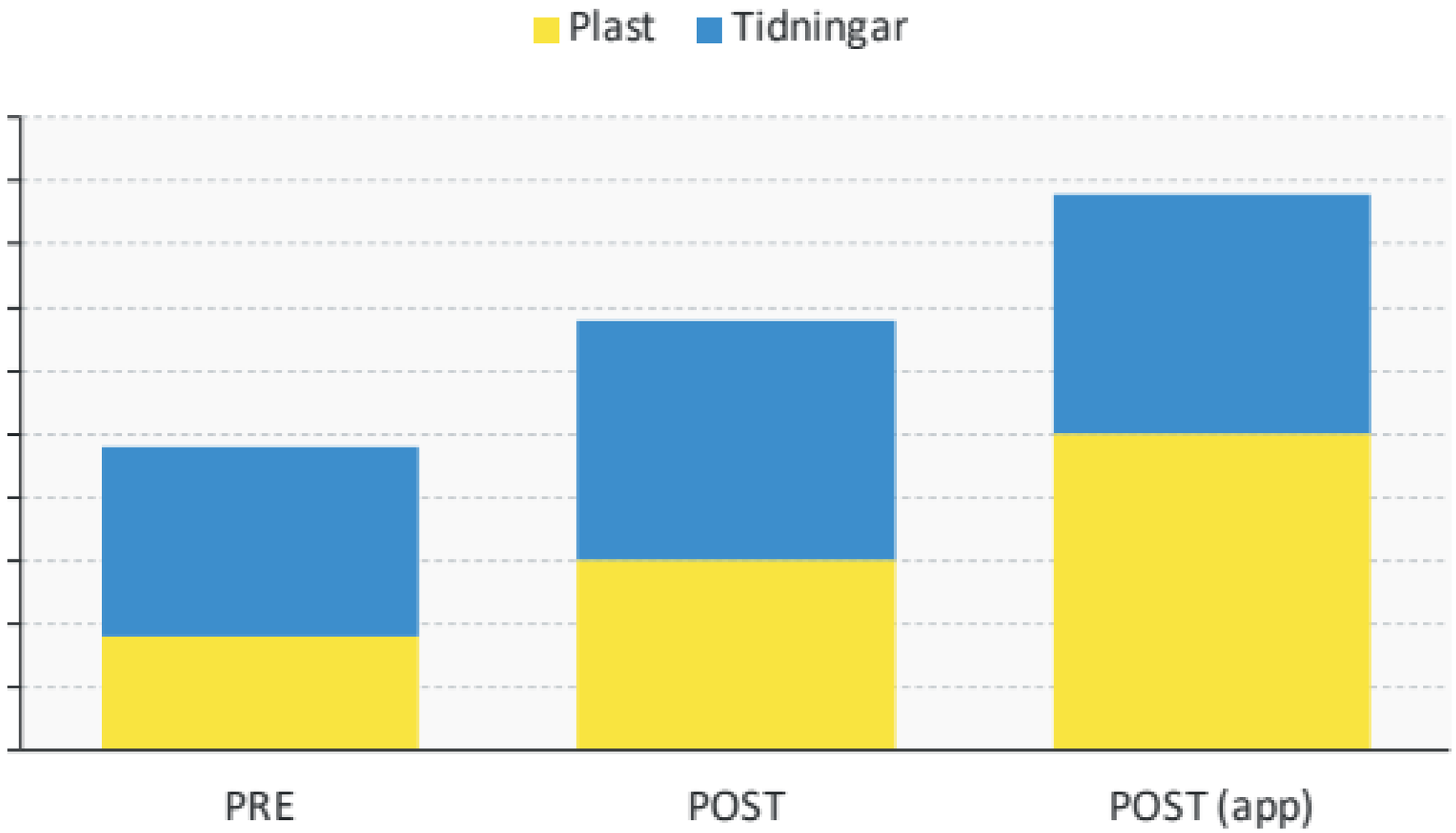
↱ App accessible for residents




Average weekly PW per period & household type
0,3
0,25
0,2
0,15
0,1
0,05
0
weight in kg
baseline
immedi
short
intermedi
long
time period
PW_no_app
PW_app


Average weekly PW per period & household type
0,3
0,25
0,2
0,15
0,1
0,05
0
weight in kg
*
*
*
*
baseline
immedi
short
intermedi
long
time period
PW_no_app
PW_app

+34 623 448 579



wasteinprogress

+34 623 448 579

Results from pilot project

+170%*

Plastic sorting in vaccum system

+26%*

(News)paper sorting in vacuum system

-4,5%

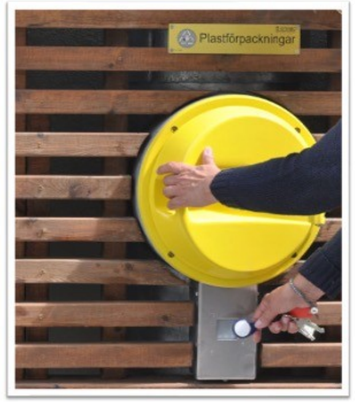
Residual waste in vacuum system

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

+34 623 448 579

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”

+34 623 448 579

Additional experiment: new & adapted waste bins

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

before

after

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

+34 623 448 579

Large-scale replication & continuation study

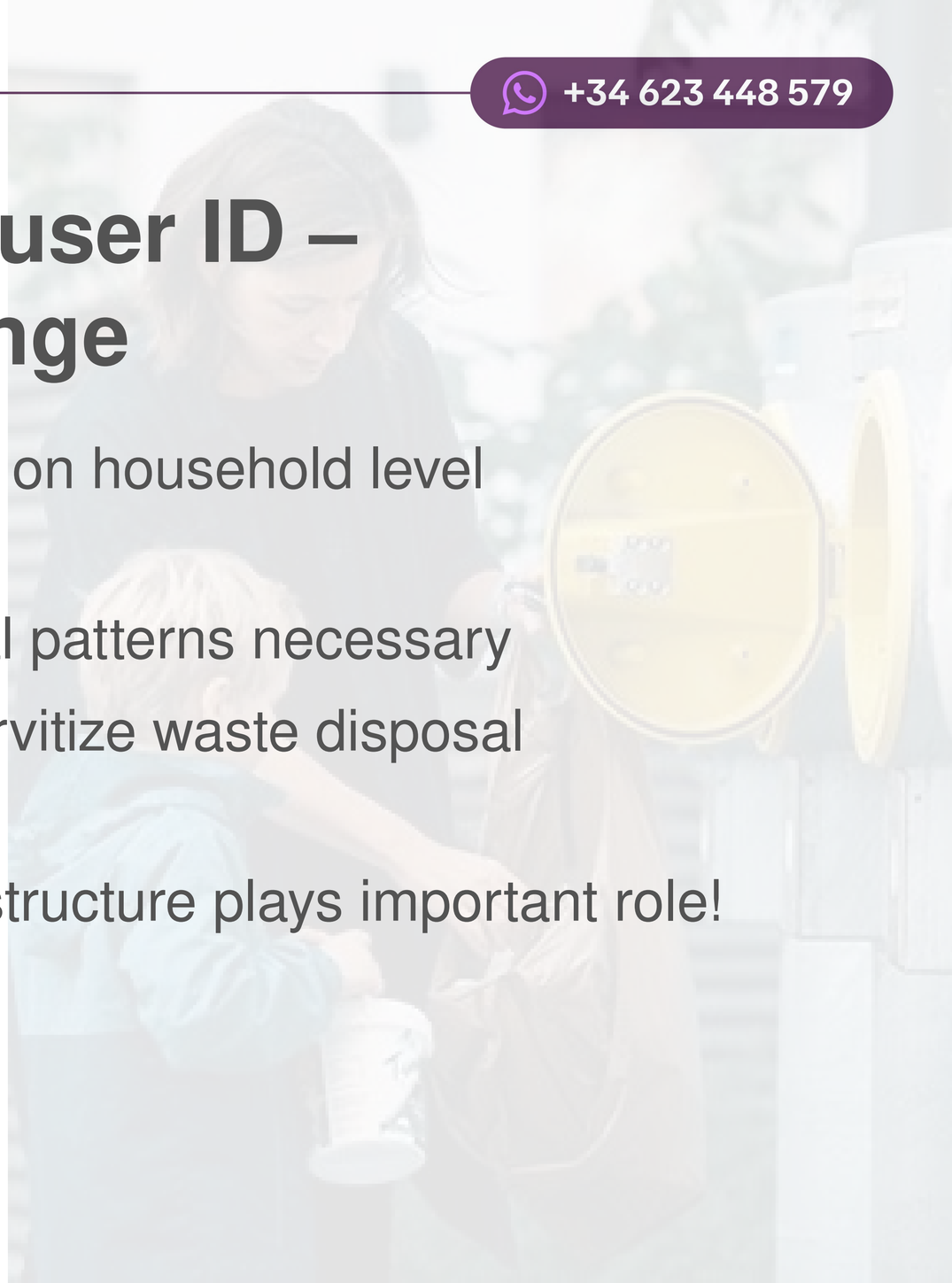
- revised app – improved layout, added ”guide” function
- ca. 2500 households divided into several sub groups
  - feedback medium: physical letter vs. access to app
  - feedback specificity: household vs. building block vs. city district
  - infrastructure @home: optimized bins for home sorting vs. current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

SUMMARY, REFLECTIONS & RECOMMENDATIONS

+34 623 448 579

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!

Henrik Siepelmeyer
henrik.siepelmeyer@uia.no
linkedin.com/in/thisishenrik

Lars-Olov Andersson
lars-olov.andersson@svoa.se