Breaking the Mold:
Utilising the full potential of PVC
off-cuts in the Danish Building Industry

By Otto Hallstrup & Santiago Rendon

SUSTAINABILITY

A HOLISTIC APPROACH

How can we incite adoption of more sustainable practices of PVC in the Danish building industry?

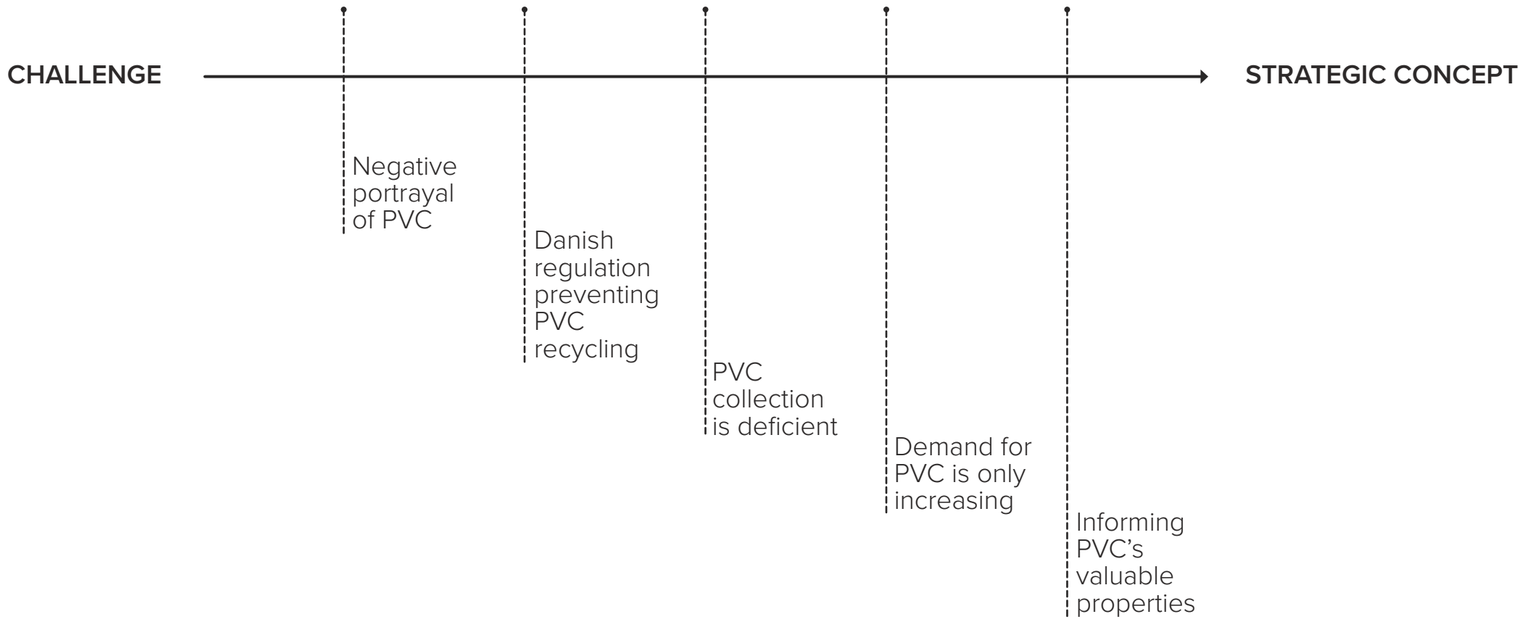
DESCRIPTION

We are delighted to unveil an exciting strategy and concept to revolutionise PVC pipe off-cuts sustainability in Denmark. Our vision is to tackle the challenge of waste by rethinking the entire lifecycle of PVC pipes.

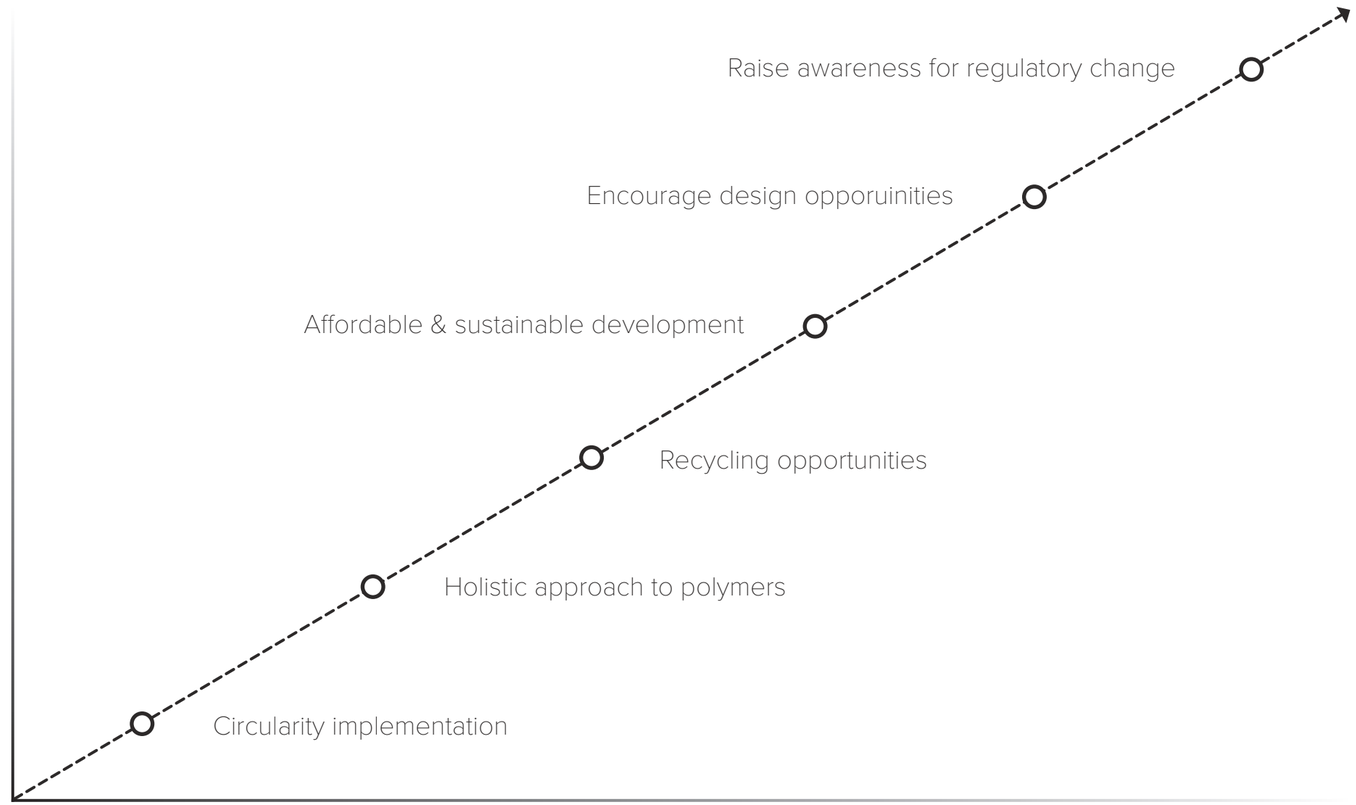
Through a comprehensive approach encompassing re-use, upcycling, re-manufacturing, and recycling, we harness the full potential of PVC pipes off-cuts. Focusing on issues related to sustainability, affordable housing, urban development, and material driven design, we have identified a potential for transforming discarded PVC off-cuts into affordable, durable, and architectural facade tiles. This poses a remarkable opportunity to drive substantial change and address pressing issues related to these themes.

With meticulous planning and consideration, our concept integrates affordable housing principles with the inherent properties of PVC. By doing so, we create a powerful synergy that enhances opportunities and maximizes impact.

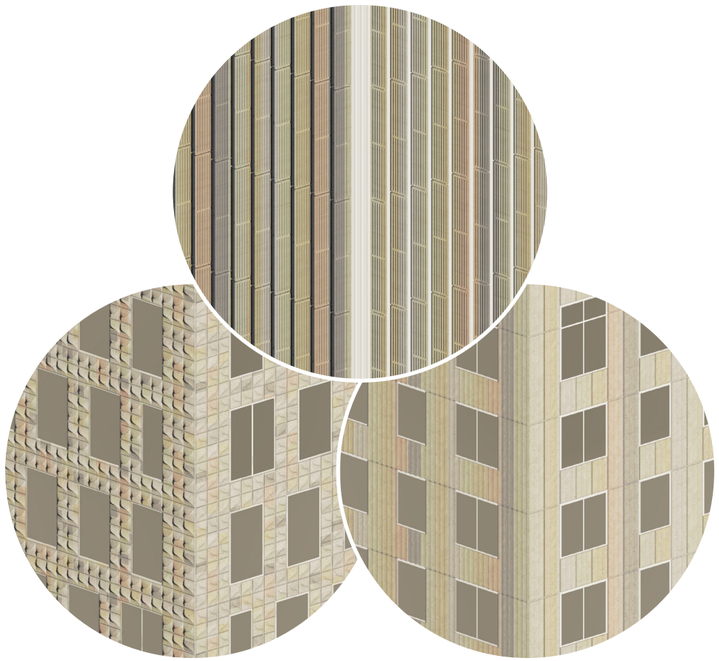
THE CONTRAINTS



OUR DESIGN CRITERIA & VISION



THE OPPORTUNITIES



1. Re-use
2. Up-Cycle
3. Re-manufacture
4. Recycle
5. Sustainable Facade Systems

UNSDG

SCOPE

- Reduce living spaces
- Holistic approach to living needs
- Durability and low maintenance
- Embracing circularity and 2nd life materials

- Lighter construction solutions
- Holistic and sustainable approach to materials
- Improve relationship with building materials

- Adapt our cities to a changing climate
- Holistic and ‘circular’ approach to developing our cities
- Conscious use of sqm’s

- High strength and rigidity
- Recycled PVC meets resource efficiency objectives
- Resistance to moisture
- Low flammability
- Resistance to chemicals and corrosion
- Low cost and ease of manufacture
- Recycled PVC reduces emission and landfill

How can the properties of plastics be used to transform our cities and ways of living? - Or not

- There is a close relationship between materials and architecture.
- A holistic perspective calls for particular materials.
- The materials available to us influence how holistically we can think, ultimately, build.
- How can a material make tomorrow's sqm conscious sustainable housing affordable.

BUILT ENVIRONMENT CHALLENGES

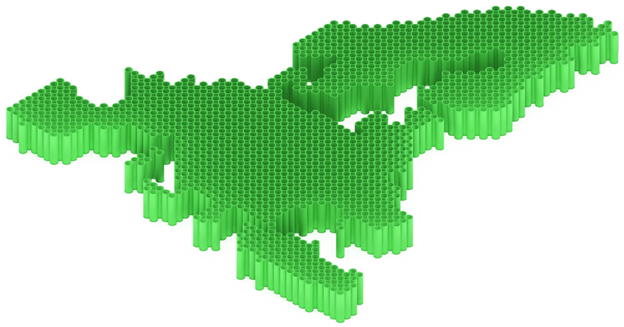
Approximately 30-40% waste comes from building and construction.

The built environment is responsible for around 40% of the global energy consumption and CO2 emissions.

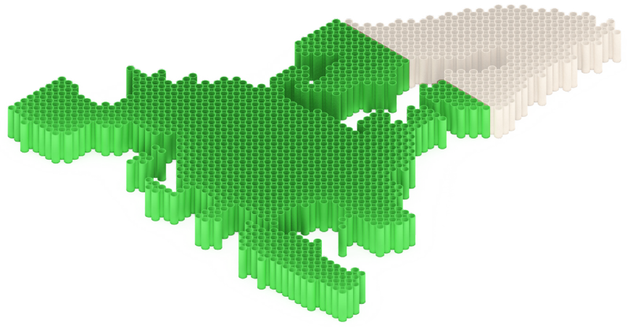
These sustainable opportunities point directly at these issues, tackling the main generator of waste.

Source: European Commission

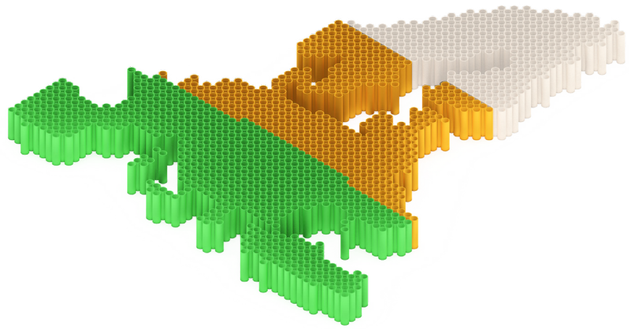
RIGID POLIVINYL CHLORIDE ‘PVC’



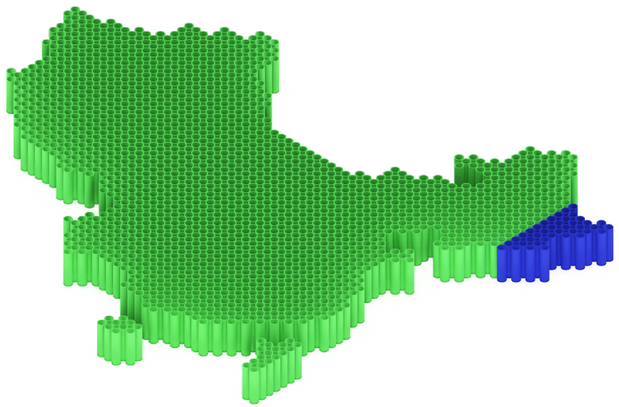
6MT MANUFACTURED IN E.U. YEARLY



70% USED IN BUILDING INDUSTRY

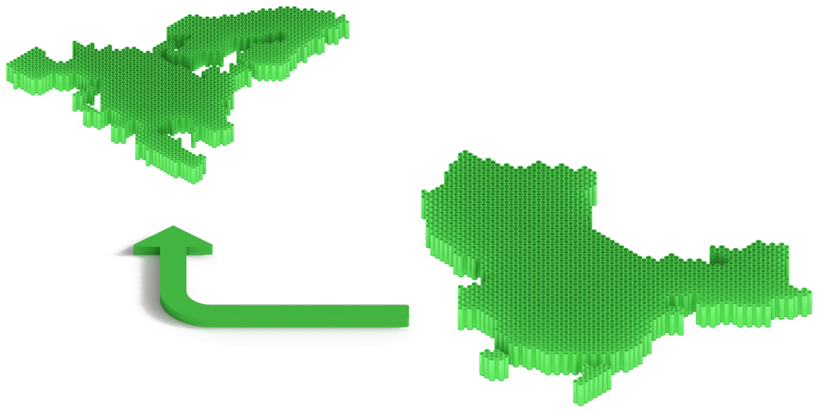


45% IN BUILDINGS USED FOR PIPES & FITTINGS



25MT MANUFACTURED IN CHINA YEARLY

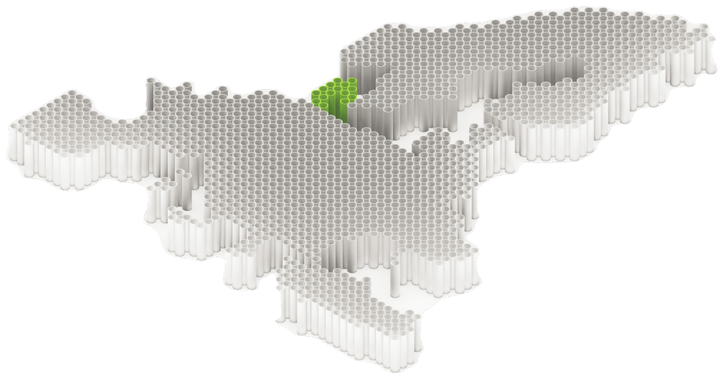
PRODUCTION TO GROW 3% P.A.



E.U. CHINESE IMPORTS OF PVC EXPECTED TO GROW

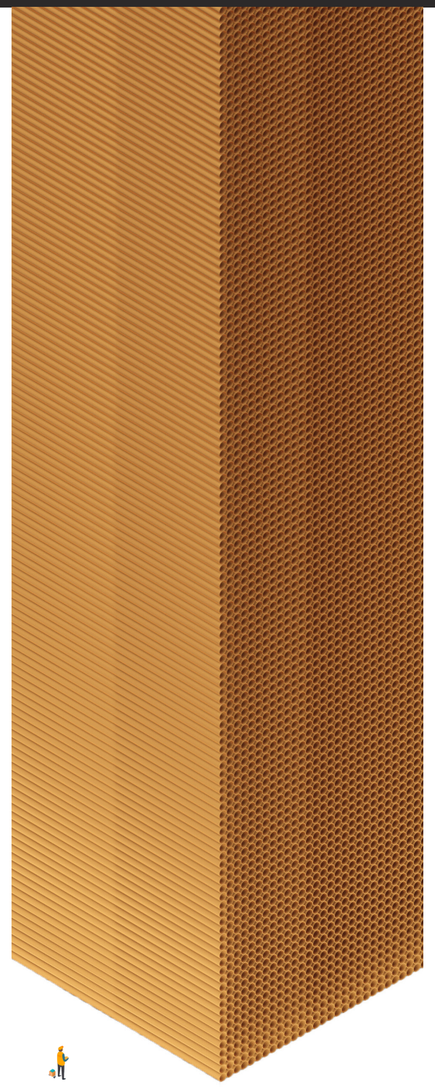
Source: EU PVC Commission

PVC IN DENMARK



70,000T IMPORTED

IN DENMARK YEARLY



3,000T PVC WASTE COLLECTED

IN DENMARK YEARLY

We wonder:

How can Denmark shift from exporting recycled PVC pipes to promoting their reuse domestically, fostering a circular economy?

What policies and incentives can drive the development of local PVC pipe recycling industries in Denmark, minimizing the need for exports and maximizing resource utilization?

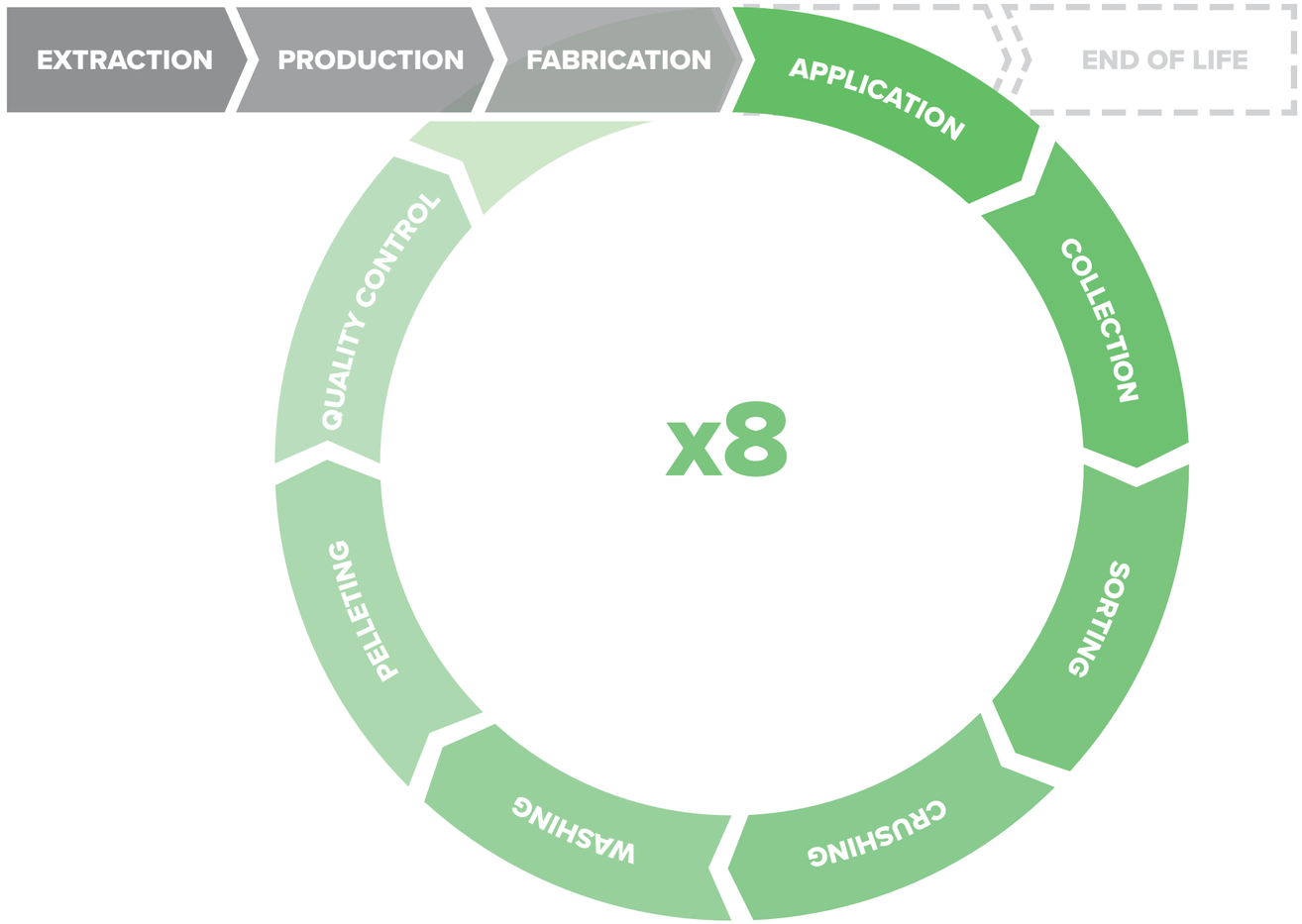
Source: WUPPI

BARRIERS: ‘ESTABLISHED VS PROPOSED’

PVC LIFE CYCLE

From linear to circular

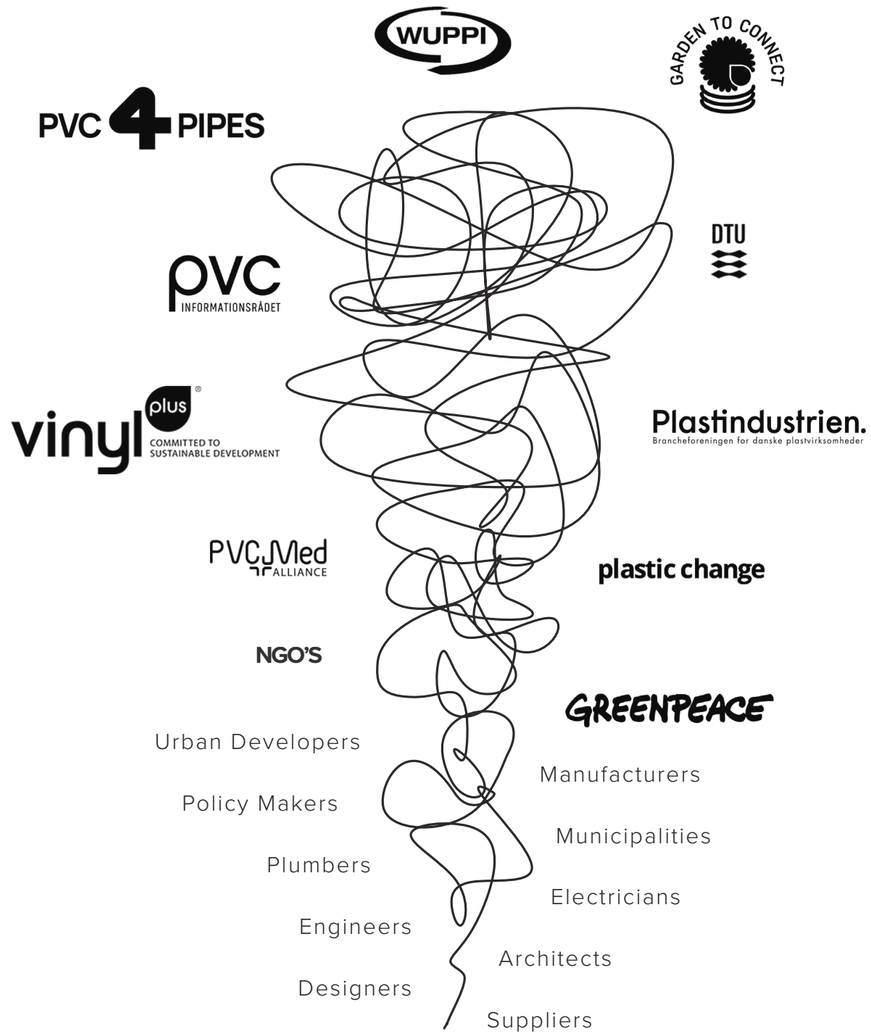
Plastics are inherently unsustainable. Therefore, once manufactured, we have a responsibility to utilise these materials for as long as possible, to minimise its negative impacts on the world. By switching from a linear to a circular approach to PVC off-cuts, we can take full advantage of the PVC we produce. In fact, if handled properly, PVC is fully recyclable for up to eight times. With a product lifespan of about 100 years for a single use case, this would potentially allow it to be in use for 800 years before reaching end of life.



INDUSTRY INSIGHTS

The PVC industry is complicated. It encompasses many opposing stakeholders, each with their own relation to the material, their own agendas, and their own set of truths.

To navigate within this, we carefully mapped the stakeholders and positions, as well as their relation between each other. Based on this research, we conducted a series of interviews with key actors to inform our project and ourselves, as an intermediary between the material PVC and the missed opportunities within the building industry.



STAKEHOLDER ANALYSIS

Ole Grøndahl Hansen | PVCIC, Director

- *PVC-U innovation (non-toxic)*
- *Legacy PVC-U vs PVC-U now*
- *Mass collection & recycling missing in DK*

Tobias Johnsen | PVCIC, Consultant

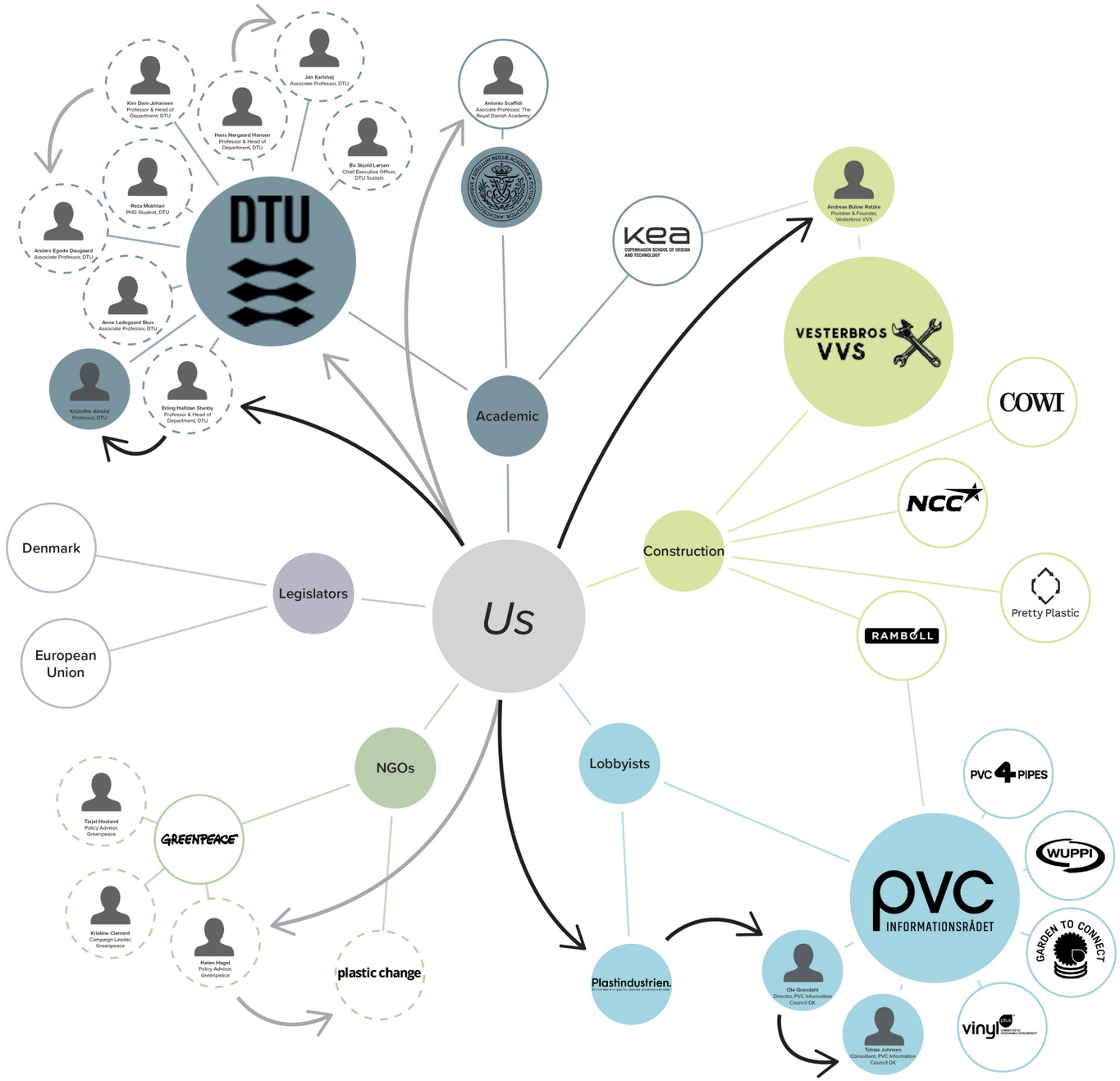
- *PVC in building industry*
- *Alternatives to PVC-U are defficient*
- *PVC regulation limitations for recycling*

Kristoffer Almdal | DTU, Physics and Bio-Chem

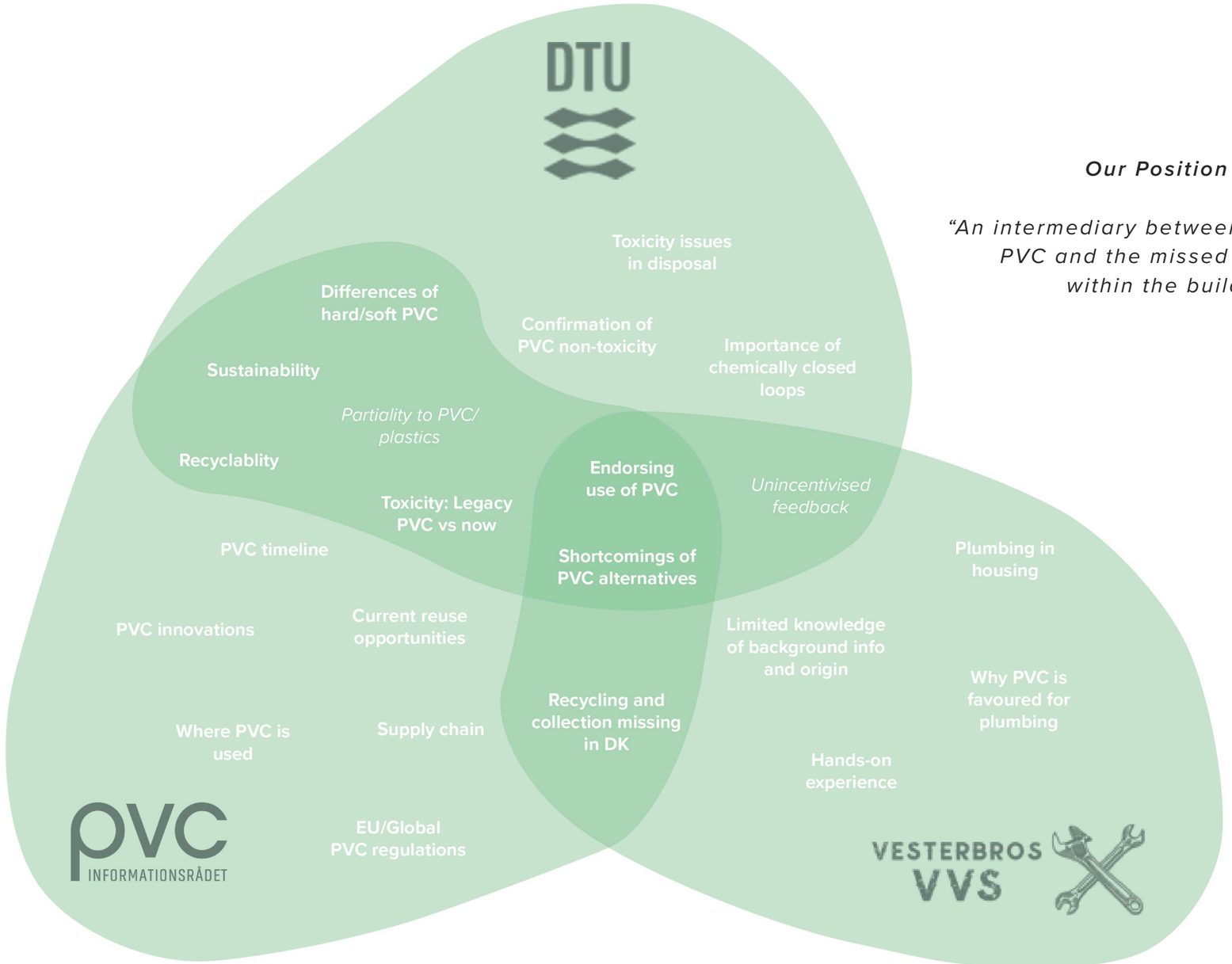
- *Rigid PVC not toxic*
- *Incorrect disposal is toxic*
- *Differences between soft and rigid*
- *Loop must contain PVC-U properties only*

Andreas Bülow Ratzke | Plumber

- *Plumbers love PVC*
- *Inproper disposal of off-cuts*
- *Interested in environment, recycling & green products*
- *Education neglects sustainability & circularity*



ACTORS INSIGHTS



Our Position as Architects

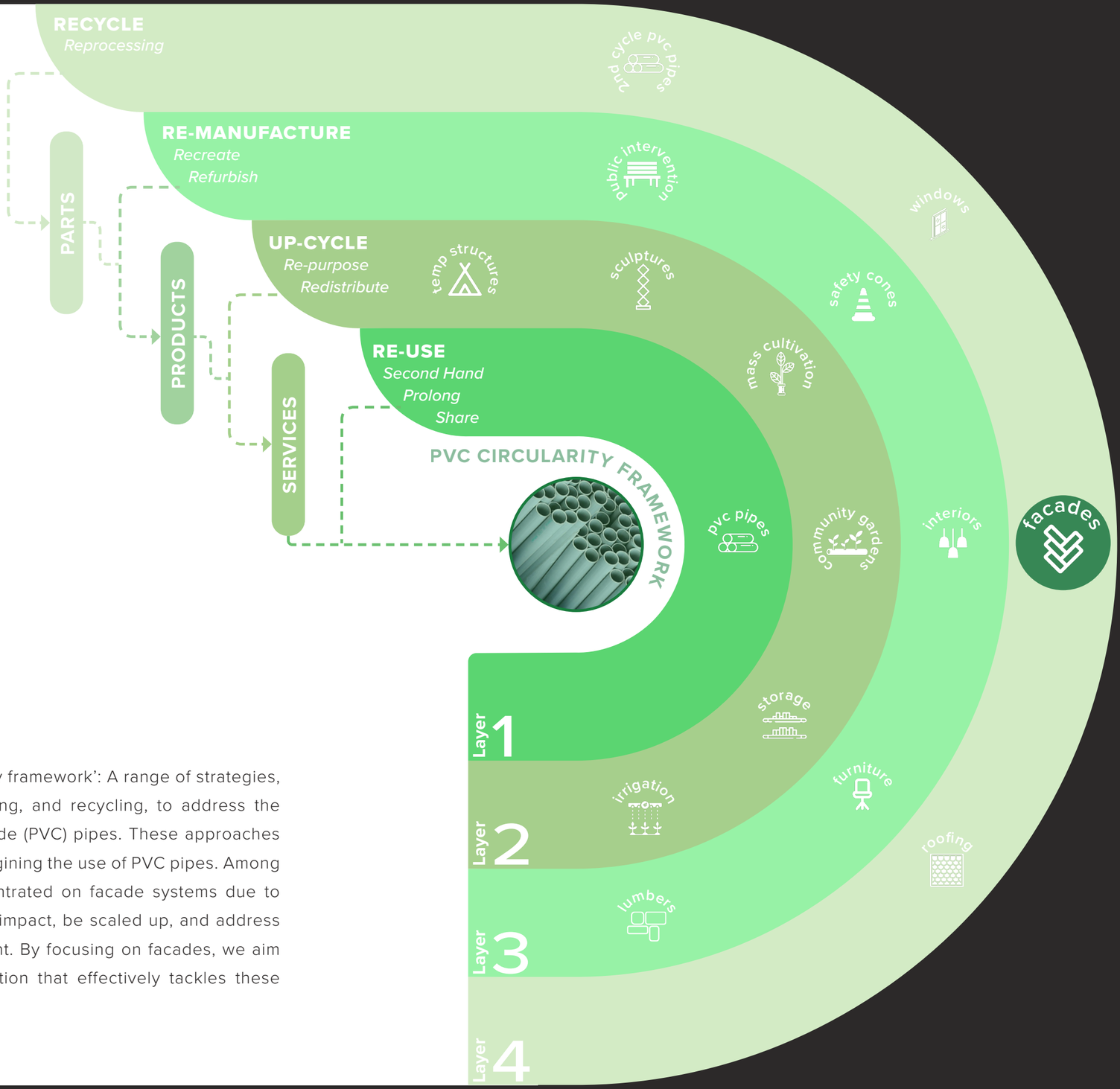
"An intermediary between the material PVC and the missed opportunities within the building industry"

| STRATEGIC APPROACH

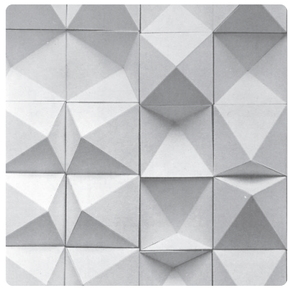
CONCEPT RATIONALE

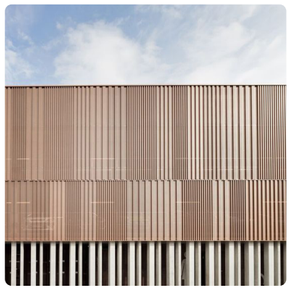
*The **What**, **Why** and vision for **How***

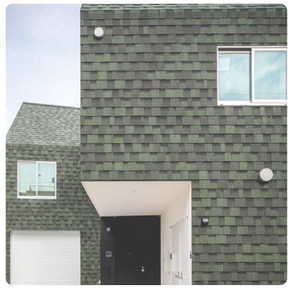
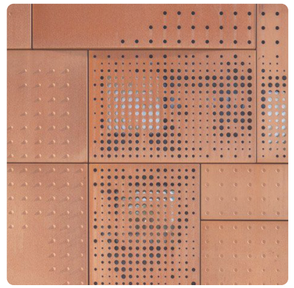
Our concept encompasses a ‘PVC circularity framework’: A range of strategies, including re-use, upcycling, re-manufacturing, and recycling, to address the challenges associated with Polyvinyl Chloride (PVC) pipes. These approaches form the basis of our exploration into re-imagining the use of PVC pipes. Among these opportunities, we specifically concentrated on facade systems due to their significant potential to make a lasting impact, be scaled up, and address major issues in the Danish built environment. By focusing on facades, we aim to develop a coherent and impactful solution that effectively tackles these challenges.



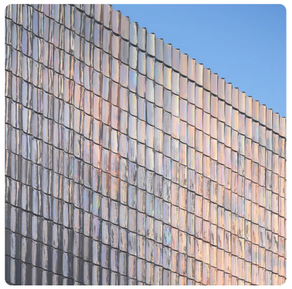
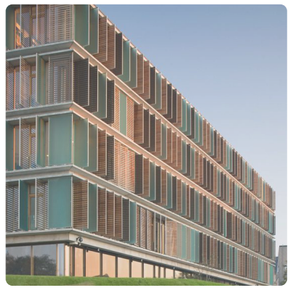
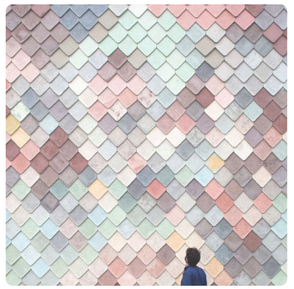
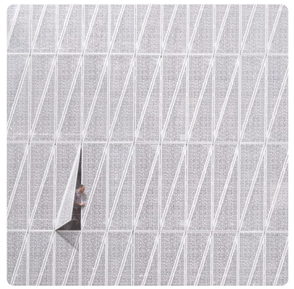
INSPIRATION / MOODBOARD



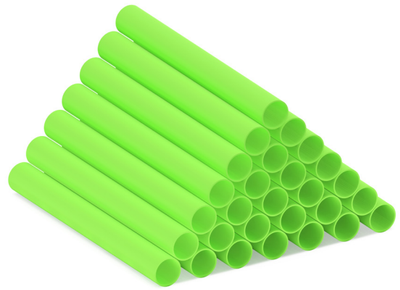





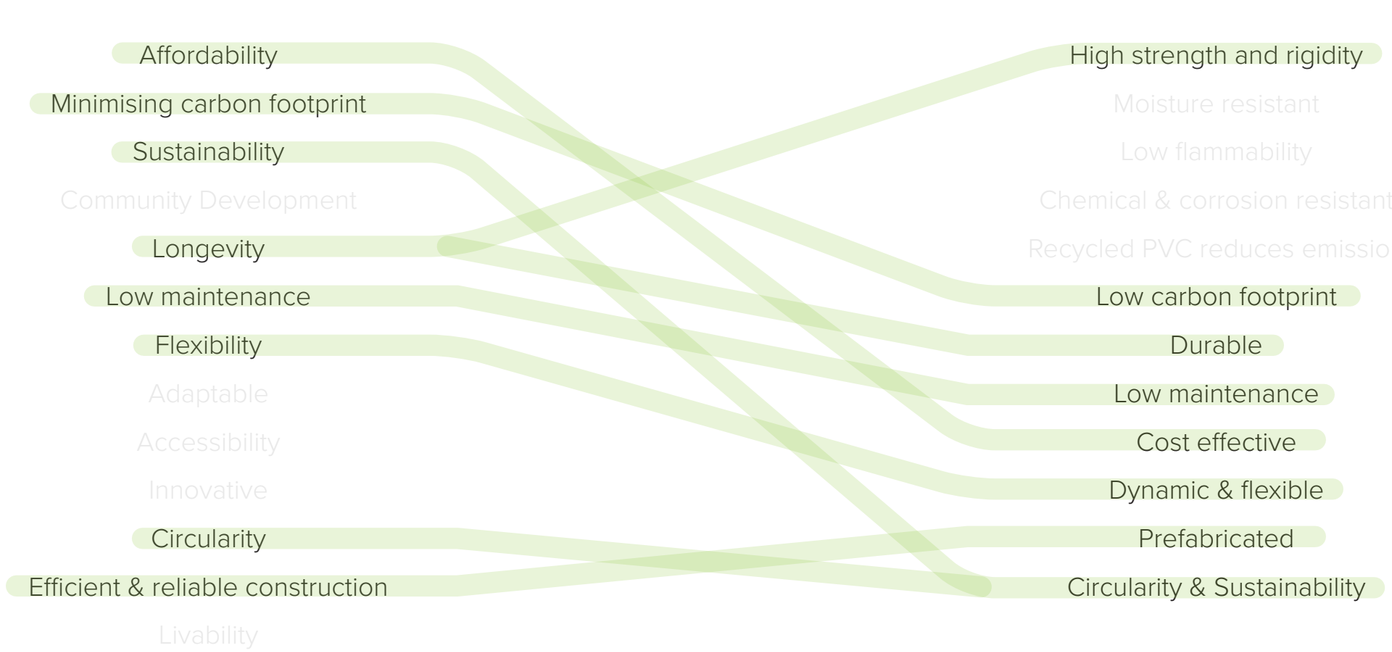

STRATEGIC CONNECTIONS

AFFORDABLE HOUSING PRINCIPLES



PROPERTIES OF PVC

Recognizing the inherent synergies and shared characteristics between affordable housing principles and the properties of PVC, we identified a distinct opportunity to combine these elements. In developing our approach, we meticulously considered these principles and qualities to ensure that our solutions aligned with a predefined success criteria. By doing so, we aimed to enhance the value of the proposed solutions while maintaining a strong focus on addressing the challenge at hand.



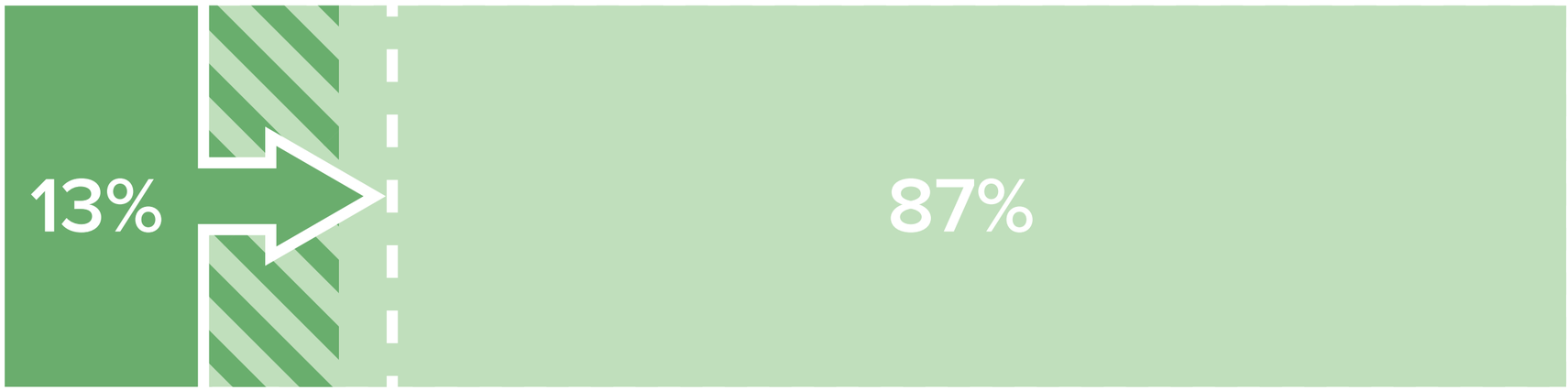
OPPORTUNITY: AFFORDABLE HOUSING

20% (600,000) of housing in Denmark is affordable...

...however, in the past 10 years, approx. 13% of new developments were affordable (35,000 of 250,000).

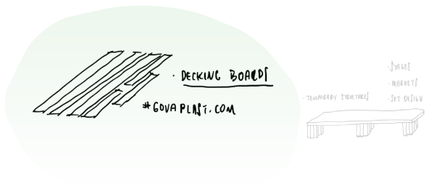
Denmark has an ambition of 25% affordable housing, and municipalities are allowed to demand this in all new developments...

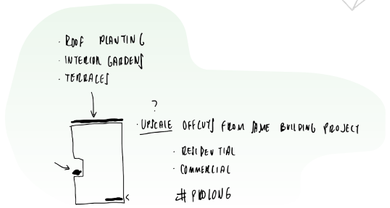
...additionally, since 2023, all new buildings are required to be LCA assessed, while buildings bigger than 1,000 m2 are prohibited from emitting more than 12 kg CO2 equivalents per m2 per year.

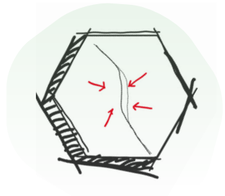


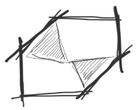
Source: Landsbyggefonden

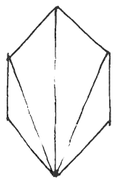
CONCEPT DEVELOPMENT

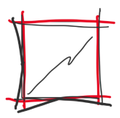


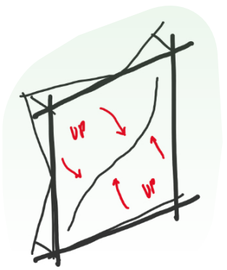


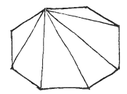


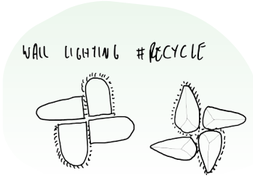


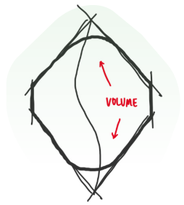


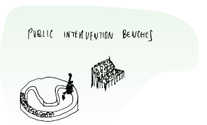


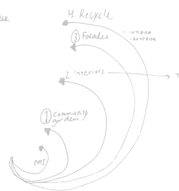


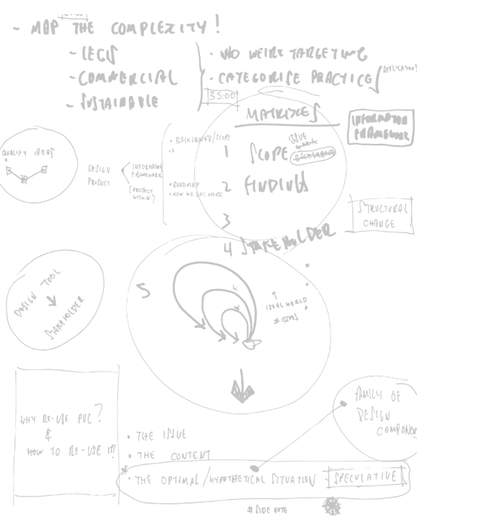


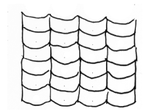


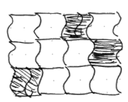


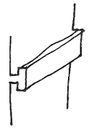


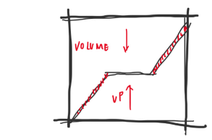












1 APPLICATION FOR EACH OF CATEGORY

RELATION TO THEMES

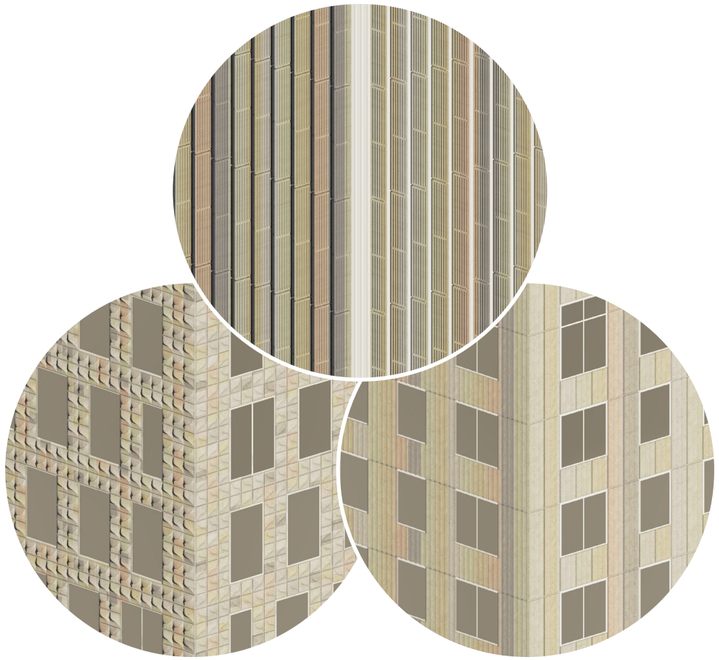
PVC is one of the **most common plastics in buildings** today

PVC properties have **shaped our cities** *(Infrastructure, resources, livability)*

Affordable housing development benefit as we **propose the adoption of recycled PVC**

Highlighting **circularity** and **sustainability**

Suitable for **new housing** developments and **re-purposed housing** buildings

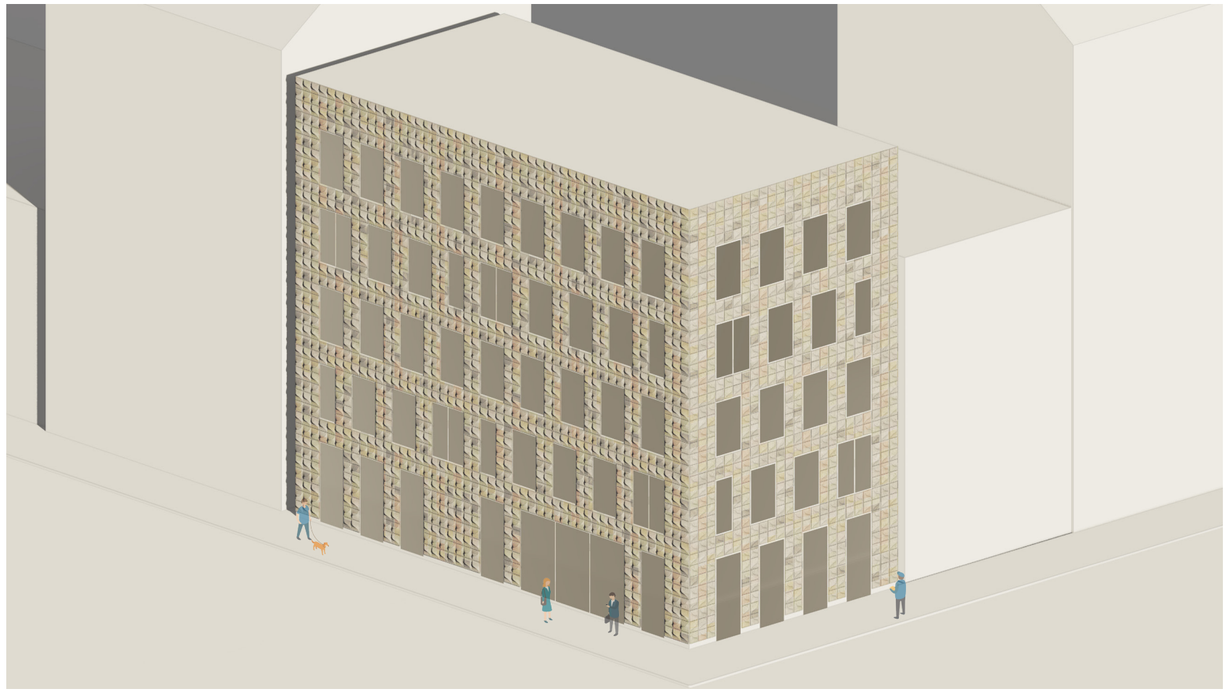


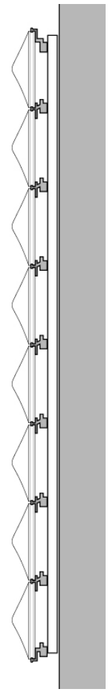
CONCEPT

Our proposed facade systems directly address these issues. we have proposed three, each with their own character architectural qualities, but their purpose remain the same.

For each, we have calculated its estimated impact in terms of PVC waste saved for a typical affordable housing development, along with the total number of facades we could produce with Denmark’s current stock of annual PVC waste.

| SYSTEM ONE - TILES

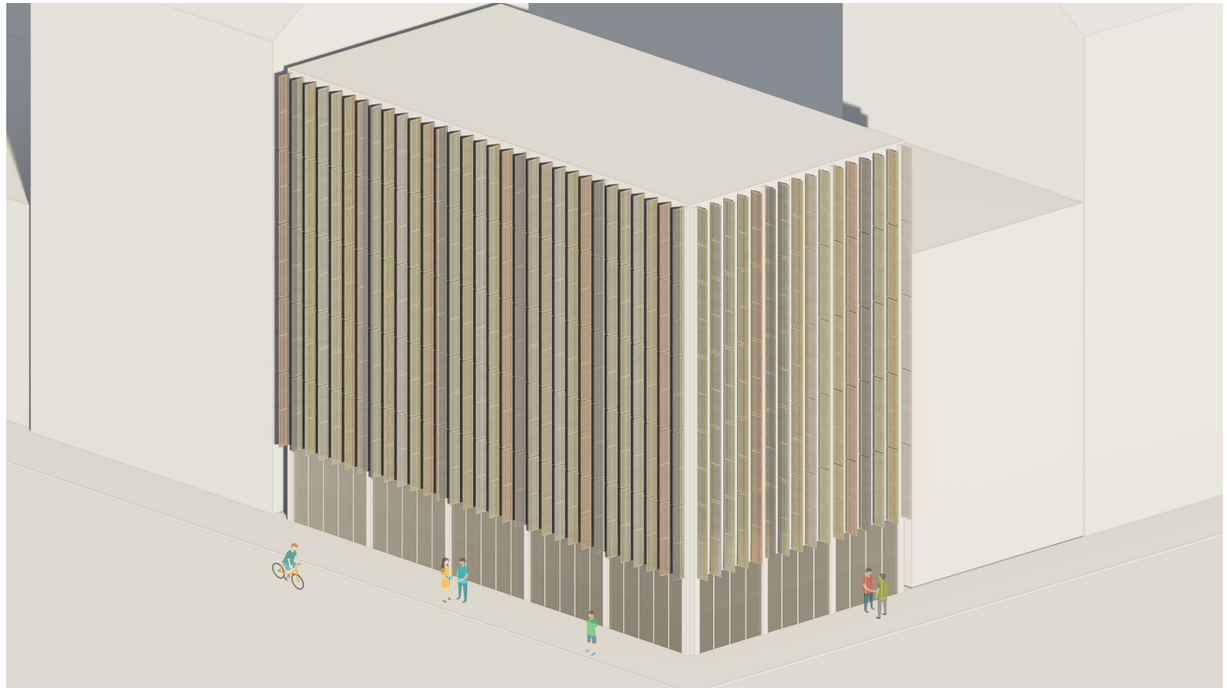


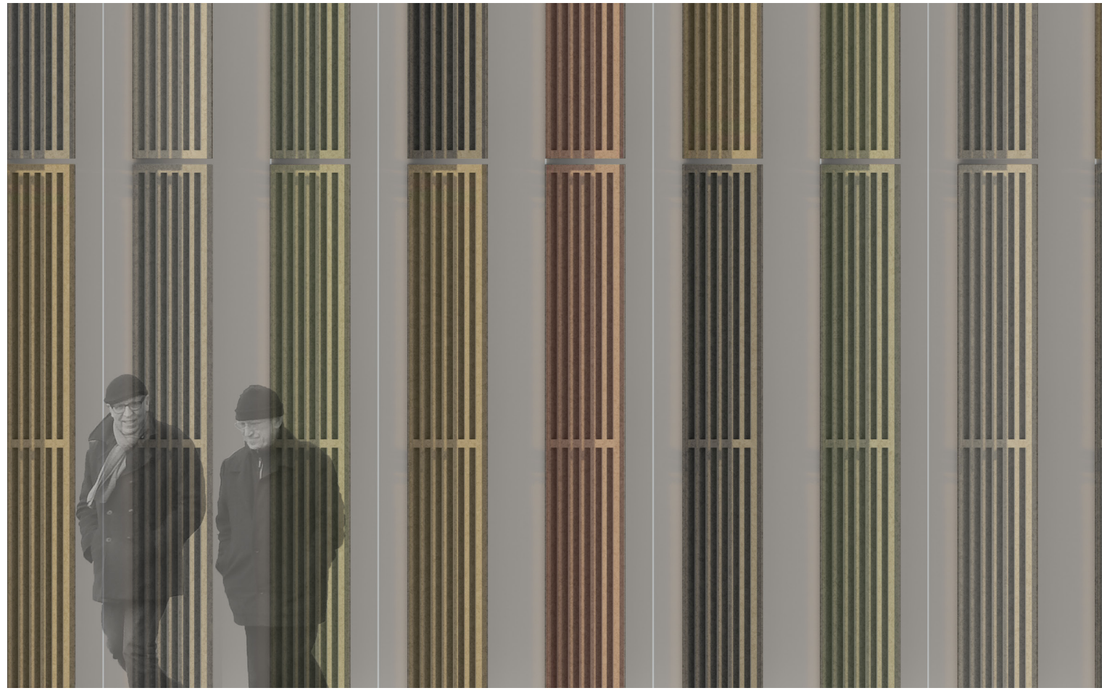


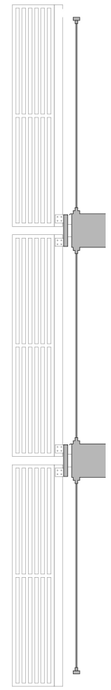
APPROX. 20-25T OF PVC RECYCLED WASTE

APPROX. 120 BUILDINGS YEARLY

| SYSTEM TWO - FINS



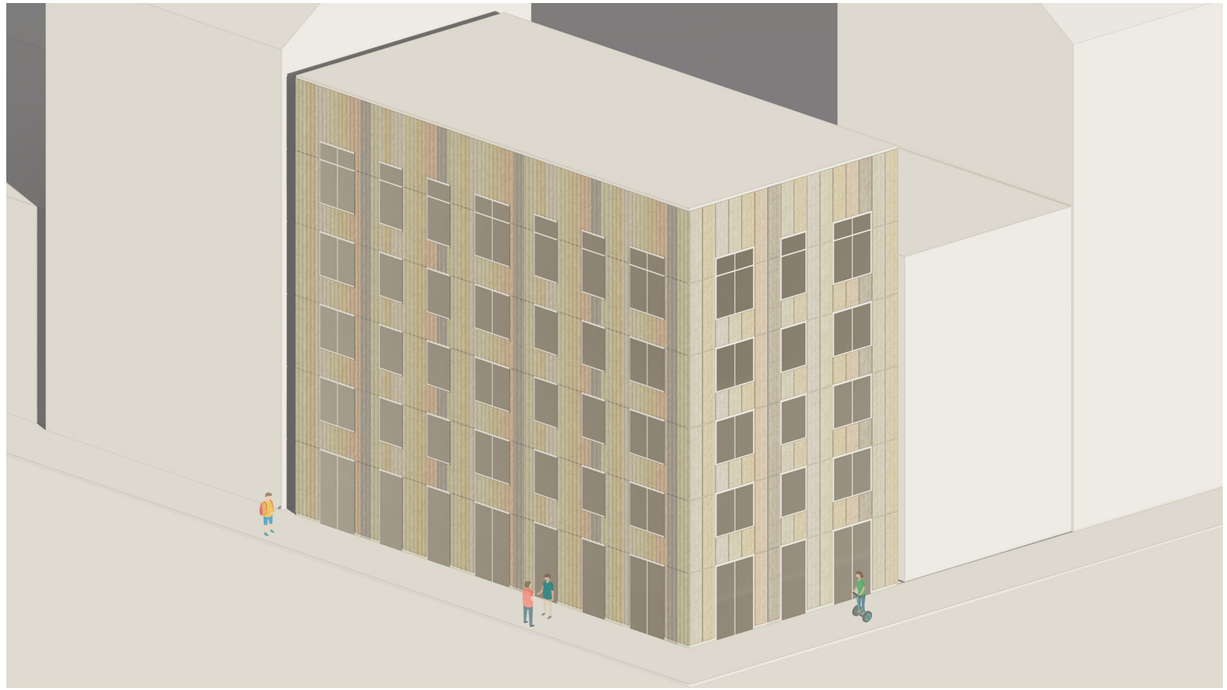


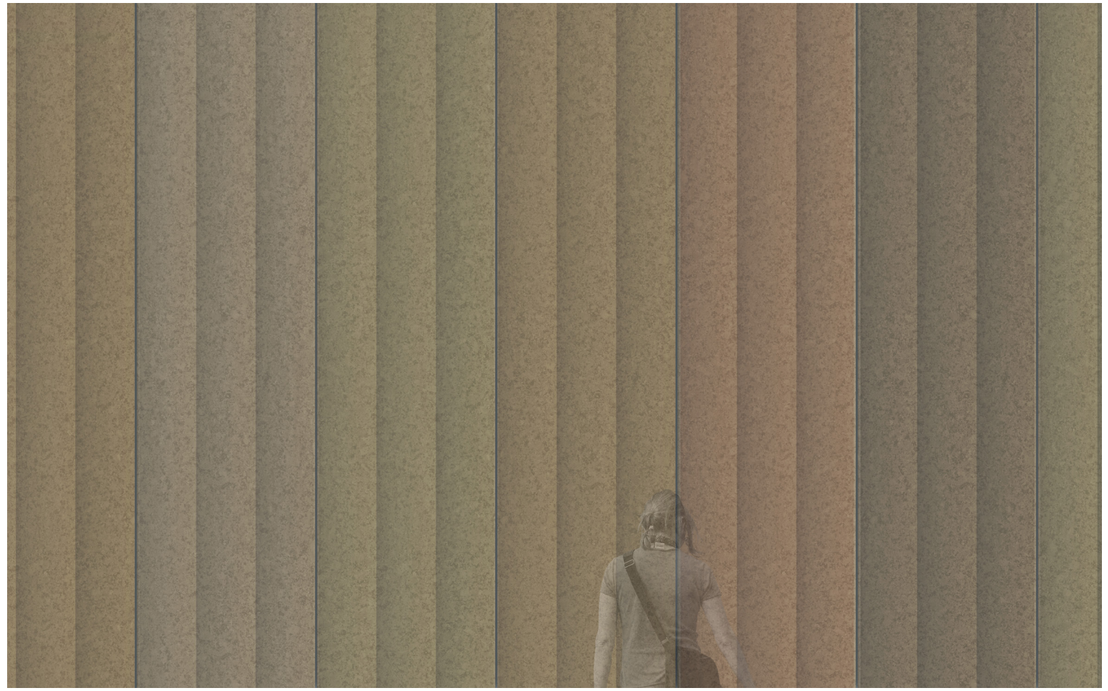


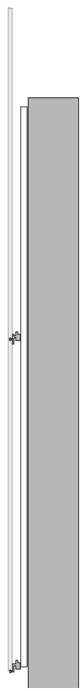
APPROX. 7.5-15T OF PVC RECYCLED WASTE

APPROX. 200 BUILDINGS YEARLY

| SYSTEM THREE - PANELS







APPROX. 15-20T OF PVC RECYCLED WASTE

APPROX. 150 BUILDINGS YEARLY

THE IDEA BEHIND FACADE SYSTEMS

WHY...

DK **unsuccessful model for the collection** PVC pipe offcuts

Toxic substances eradicated which enables re-use and recycling

We want to provide **circularity initiatives for PVC off-cuts**

Enabling more affordable housing (cheaper/sustainable solutions)

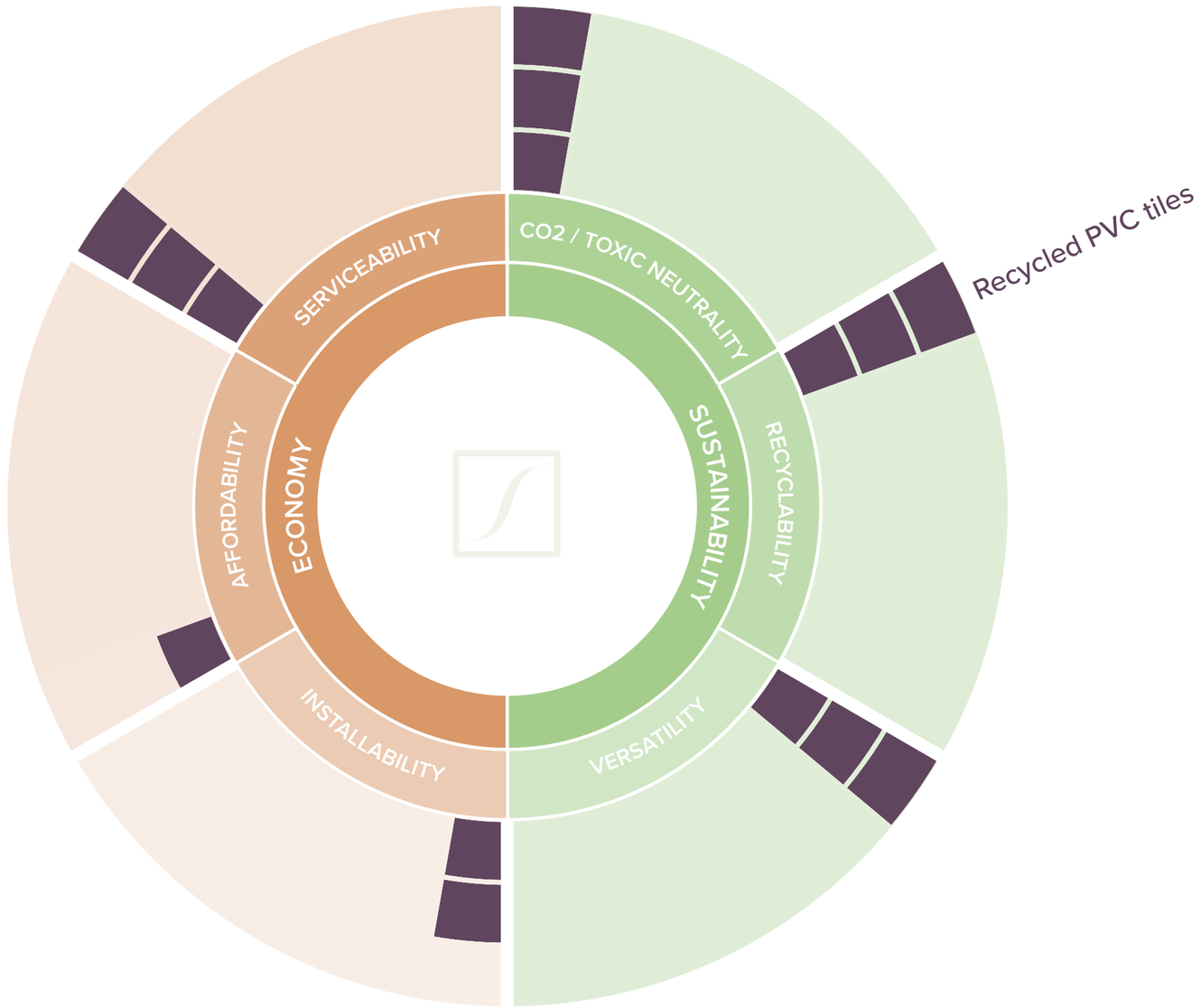
Becoming a **precedent for harden PVC installation waste** handling

Reduce waste and incineration by re-thinking PVC off-cuts afterlife

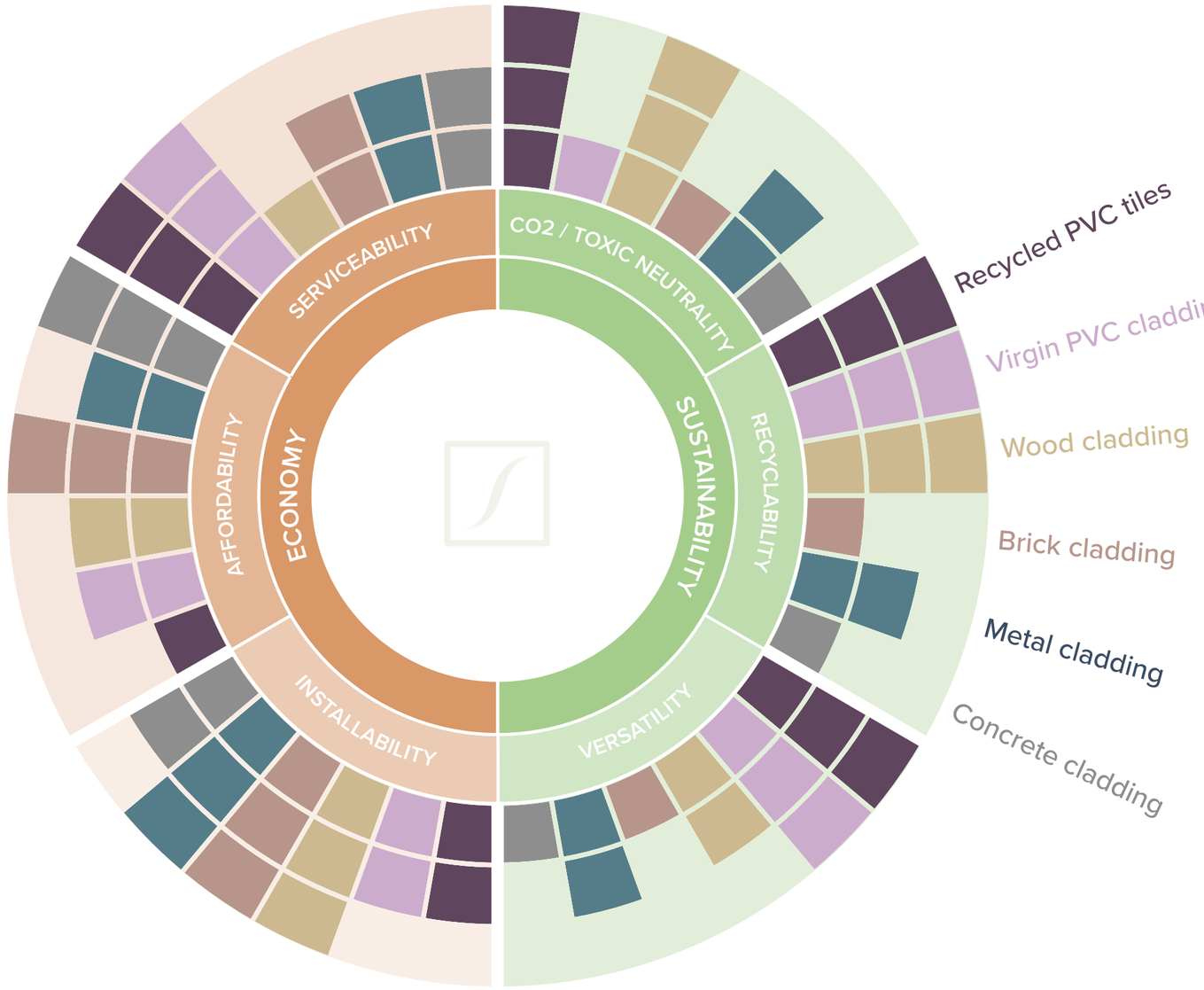
HOLISTIC APPROACH

To justify our proposal, we developed a holistic tool to compare economic and sustainable qualities of the most typical facade materials used in affordable housing today.

HOLISTIC APPROACH



HOLISTIC APPROACH



Source: Various

THIS ENABLES...

...Taking advantage of PVC properties in buildings:

Fire resistance

Durability (Impact, shock, safety)

Weather resistance (Wind, rain, snow)

UV resistance

...Faster construction/assembly:

Simplified prefabricated envelopes are **easier to install**

Reduced **amount of fixings**

...Affordable housing:

Reducing virgin material extraction (Re-use & Re-cycle)

Sustainable material (could tap into possible sustainable subsidies?)

Government / public sector incentives to use sustainable materials

...Sustainability (circularity):

Recycling PVC installation waste pipes in DK

Prolonging the life of an affordable and durable material

Avoiding **incineration and landfill**

Establishing initiatives for **collection and re-use of PVC**

THANK YOU FOR YOUR CONSIDERATION

Otto Hallstrup

Santiago Rendon