To lease, or not to lease?

A critical evaluation of Product-Service-System building components in rental housing

TU Delft BK Bouwkunde
Department of Management in the Built Environment


UBER

“People do not need cars and washing machines, but mobility and clean clothes.”

(Meijkamp, 1998)

Car

Product

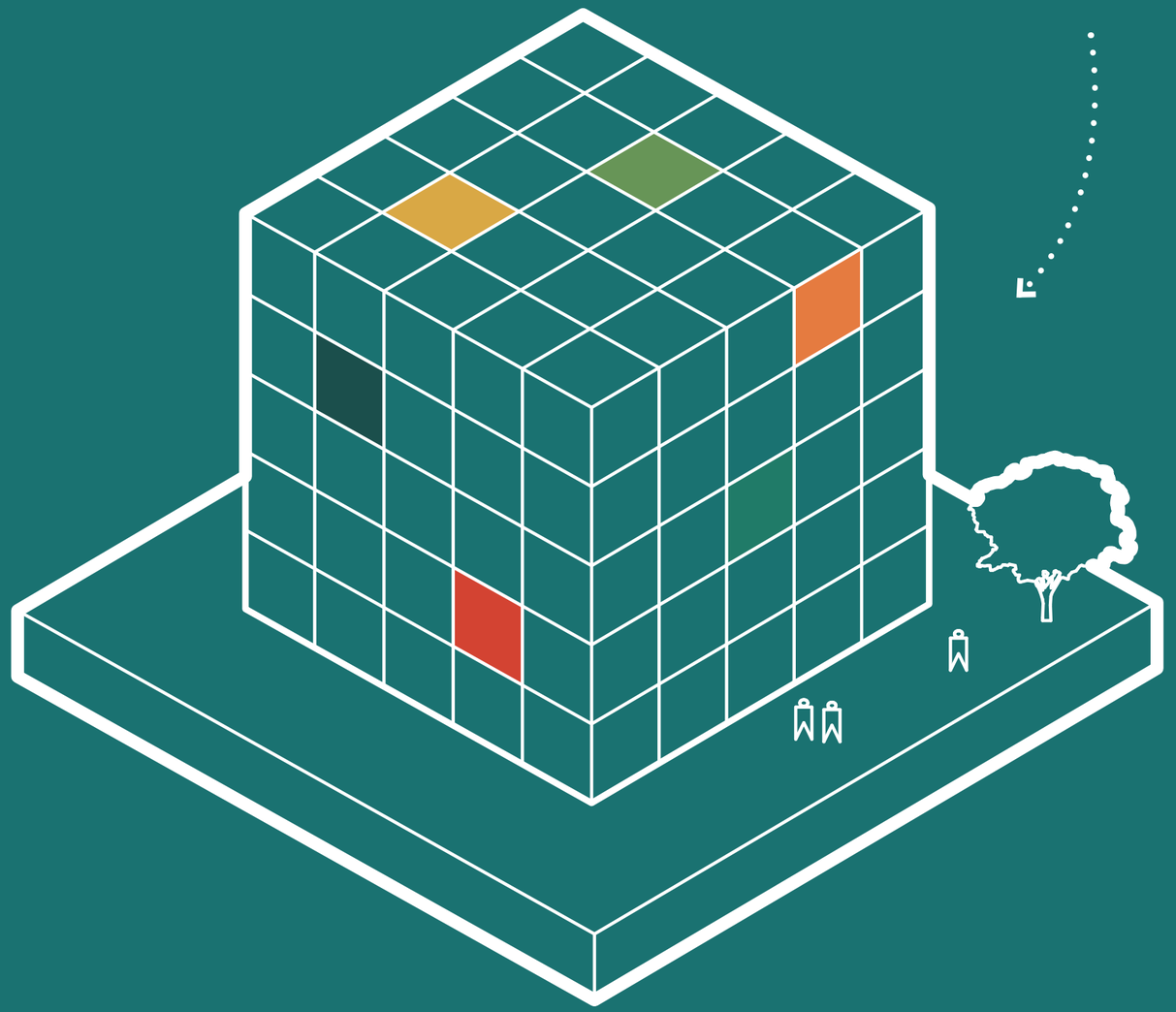
Service

Driver + App

Product-Service-System

“Product-as-a-Service”

Product-Service-Systems (PSSs)



in buildings

Why Study PSSs?

Why Study PSSs?

Business

- Capture more value
- Gain customer loyalty
- Offer both products & services

Vandermerwe & Rada (1988), Xia et al. (2021)

Why Study PSSs?

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- Capture more value
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Vandermerwe & Rada (1988), Xia et al. (2021)

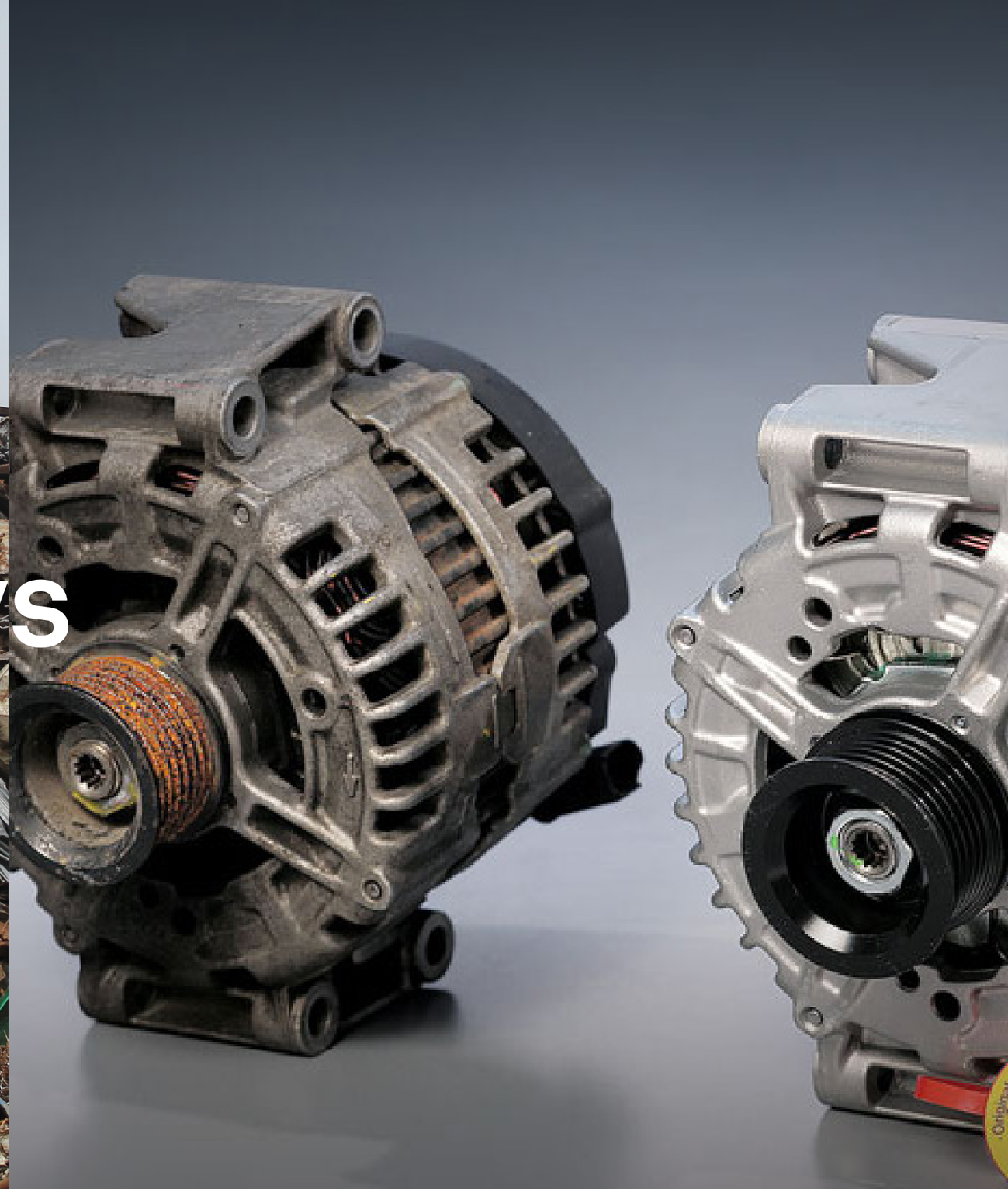
Environment

- Resource consumption
  = climate change
- PSSs can reduce consumption

Satterthwaite (2009), Ellen MacArthur Foundation (2013)

Manufacturer Incentives

VS



Manufacturer Incentives

Linear Economy

“Business-as-usual”

Sell

- Sell as many products as possible with planned obsolescence
- Continuous extraction & disposal of materials

vs

Mont (2002)

Manufacturer Incentives

Linear Economy

“Business-as-usual”

Sell

- Sell as many products as possible with planned obsolescence
- Continuous extraction & disposal of materials

VS

Circular Economy

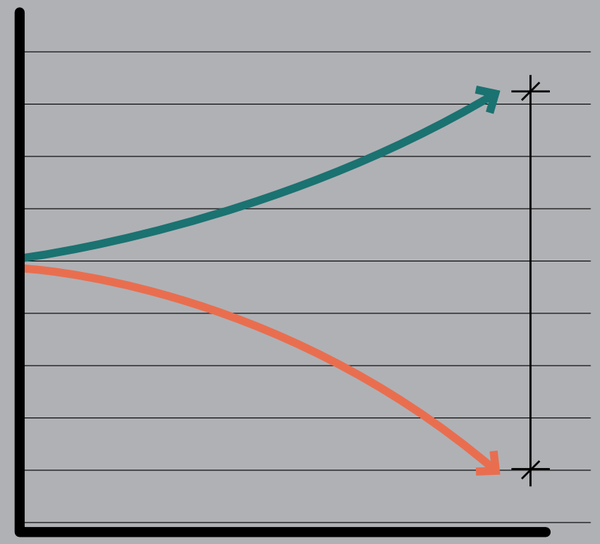
Product-Service-Systems

Rent or Lease

- Develop long lasting products
- Remanufacture old products into new products
- Minimize material waste

Mont (2002)

PSSs are business models capable of decoupling economic growth from resource extraction



Lacy et al. (2014), Coalition Circular Accounting (2020)

State of the Art

Latest PSS-in-the-Built-Environment research focuses on the **supply** (design & delivery) of PSSs...

2018

Integrated façades as a Product-Service System – Business process innovation to accelerate integral product implementation

Juan F. Azcárate-Aguerre[1], Alexandra den Heijer[2], Tillmann Klein[1]

1 Department of Architectural Engineering and Technology (AE+T), Faculty of Architecture and the Built Environment, TU Delft, Delft, the Netherlands

2 Department of Management in the Built Environment (MBE), Faculty of Architecture and the Built Environment, TU Delft, Delft, the Netherlands

Abstract

The Circular Economy (CE) attempts to realign business incentives, across all fields of human industry, to support the preservation of raw materials within closed economic loops. Within this conceptual frame, Product-Service Systems (PSS) combine the use of tangible products such as building technologies, with intangible maintenance and monitoring services, to enhance the delivery of valuable performance while limiting the use of materials and other finite resources. This paper explores the potential for the application of CE and PSS organisation principles in the delivery of Facades-as-a-Service. It explores how the benefits brought about by this way of thinking - lower initial capital requirements, material ownership retention by suppliers, and long-term interdisciplinary collaboration - could lead to a more efficient facade construction industry, while accelerating the rate and depth of building energy renovations.

Within the current process for designing, manufacturing, and operating facades there is a gap between supply-side discoveries and demand-side needs, which hinders the implementation of resource-efficient facades. Façade-leasing as a form of product-service system keeps suppliers committed, throughout the building's service-life, to safeguard optimum performance in operation, while actively stimulating clients to adopt innovative technical solutions.

The paper elaborates on both supply-side façade innovations and the demand-side conditions necessary to implement such business models, and also explores the costs and benefits of product-service systems as new collaboration models to align supply and demand incentives. It builds upon the research project "Façade leasing" (Azcarate-Aguerre, J.F., 2014) and combines knowledge about facade design and engineering (supply-side approach) with the knowledge about client needs, performance criteria, and willingness to pay (demand-side approach). The research methodology includes a literature review and expert interviews, integrating both theory and practice.

This paper argues that a Product-Service System approach to façade design, construction, operation, and renovation could accelerate the rate and depth of building energy renovations. It could also provide incentives to supply- and demand-side stakeholders, to implement Circular Economy principles through new models of product ownership, service contracting, and performance delivery. It aims at establishing the general conceptual frame of a Product-Service System for leasable facades, setting the basic parameters to be taken into account when designing a PSS-based business model, and formulating its value proposition.

Keywords

product-service systems (PSS), façade-as-a-service, leasing, resource-efficient innovation, integrated façades, circular economy

DOI: 10.7480/jfde.2018.1.1840

2019

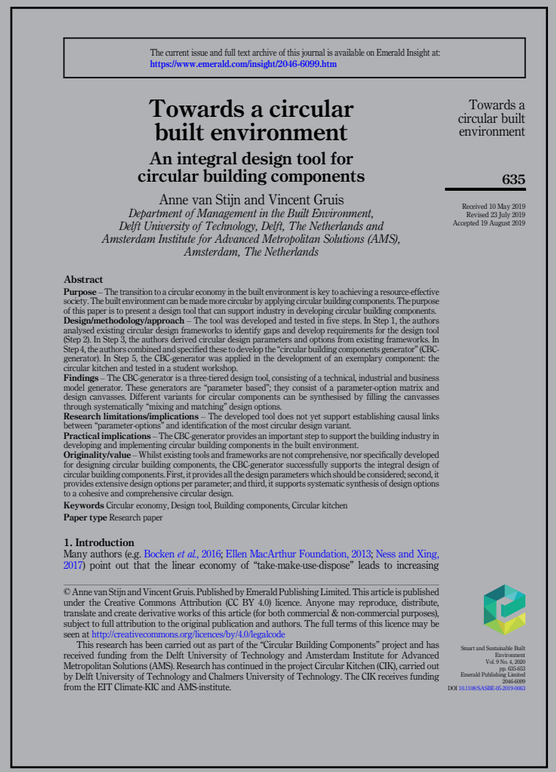
BUILDING VALUE

A pathway to circular construction finance

A report by:

With the support of the Community of Practice:

2019



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Towards a circular built environment

Towards a circular built environment

An integral design tool for circular building components

Anne van Stijn and Vincent Gruis
Department of Management in the Built Environment, Delft University of Technology, Delft, The Netherlands and Amsterdam Institute for Advanced Metropolitan Solutions (AMS), Amsterdam, The Netherlands

Abstract

Purpose – The transition to a circular economy in the built environment is key to achieving a resource-effective society. The built environment can be made more circular by applying circular building components. The purpose of this paper is to present a design tool that can support industry in developing circular building components.

Design/methodology/approach – The tool was developed and tested in five steps. In Step 1, the authors analysed existing circular design frameworks to identify gaps and develop requirements for the design tool (Step 2). In Step 3, the authors derived circular design parameters and options from existing frameworks. In Step 4, the authors combined and specified these to develop the "circular building components generator" (CBC-generator). In Step 5, the CBC-generator was applied in the development of an exemplary component: the circular kitchen and tested in a student workshop.

Findings – The CBC-generator is a three-tiered design tool, consisting of a technical, industrial and business model generator. These generators are "parameter based"; they consist of a parameter-option matrix and design canvasses. Different variants for circular components can be synthesised by filling the canvasses through systematically "mixing and matching" design options.

Research limitations/implications – The developed tool does not yet support establishing causal links between "parameter-options" and identification of the most circular design variant.

Practical implications – The CBC-generator provides an important step to support the building industry in developing and implementing circular building components in the built environment.

Originality/value – Whilst existing tools and frameworks are not comprehensive, nor specifically developed for designing circular building components, the CBC-generator successfully supports the integral design of circular building components. First, it provides all the design parameters which should be considered; second, it provides extensive design options per parameter; and third, it supports systematic synthesis of design options to a cohesive and comprehensive circular design.

Keywords Circular economy, Design tool, Building components, Circular kitchen
Paper type Research paper

1. Introduction

Many authors (e.g. Bocken *et al.*, 2016; Ellen MacArthur Foundation, 2013; Ness and Xing, 2017) point out that the linear economy of "take-make-use-dispose" leads to increasing

This research has been carried out as part of the "Circular Building Components" project and has received funding from the Delft University of Technology and Amsterdam Institute for Advanced Metropolitan Solutions (AMS). Research has continued in the project Circular Kitchen (CIK), carried out by Delft University of Technology and Chalmers University of Technology. The CIK receives funding from the EIT Climate-KIC and AMS-institute.

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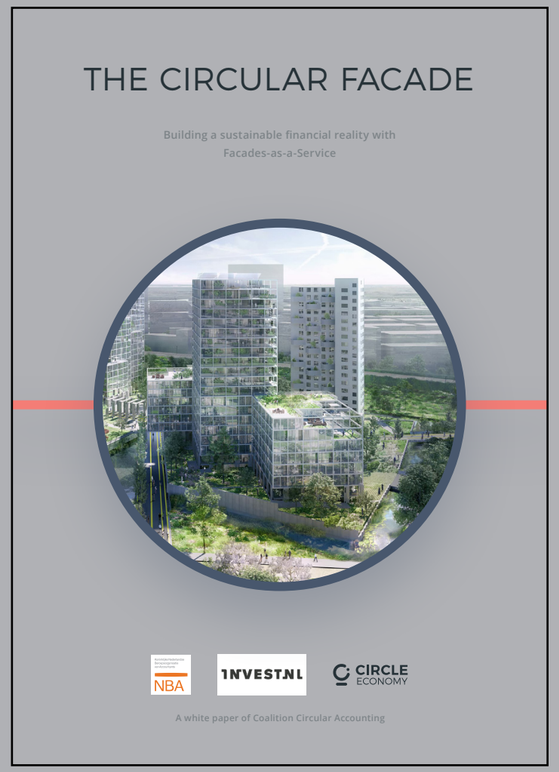


THE CIRCULAR FACADE

Building a sustainable financial reality with Facades-as-a-Service

A white paper of Coalition Circular Accounting

Problem Statement & Gap in Knowledge

However, to be implemented at scale,

PSSs must demonstrate clear value to decision-makers who use them

...Currently limited research exploring a **demand** perspective...

Problem Statement

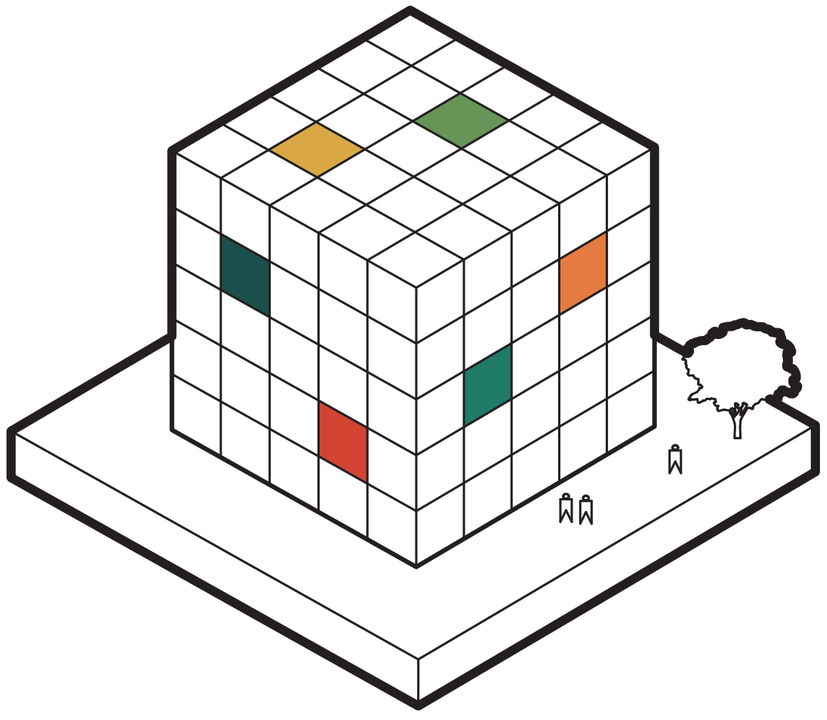
Netherlands

1.2 million new homes constructed by 2050, of which, 40% will be rental housing...

...but, construction directly contradicts Government goal of circular economy by 2050...

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties (2019), ABF Research (2020)

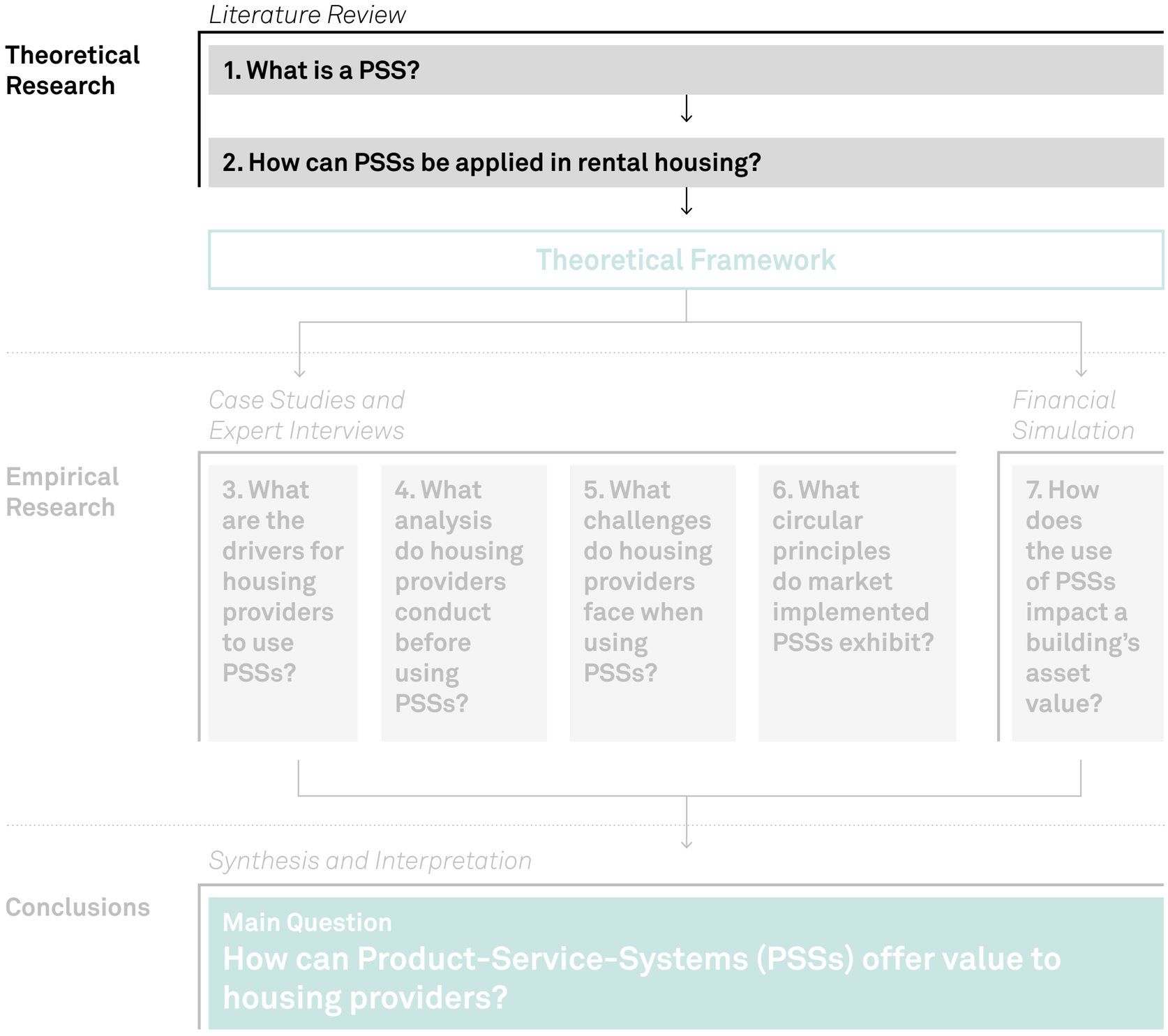
Main Research Question



How can Product-Service-Systems (PSSs) offer value to housing providers (HPs)?

(Dutch + American rental housing context)

Methodology



What is a PSS?

Any combination of products and services that deliver a solution to a user...

Mont (2004)

What is a PSS?

Any combination of products and services that deliver a solution to a user...

In buildings, many components (elevators, kitchens, HVAC) can potentially be offered as product-service-systems

Mont (2004)

How can PSSs be applied in rental housing?

Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

How can PSSs be applied in rental housing?

Payment allocation	>50 %Product			>50% Service
Type	**1. Input-based**	**2. Availability-based**	**3. Usage-based**	**4. Performance-based**
How function is accessed	Purchased	Typically Leased *(purchasing is possible)*		

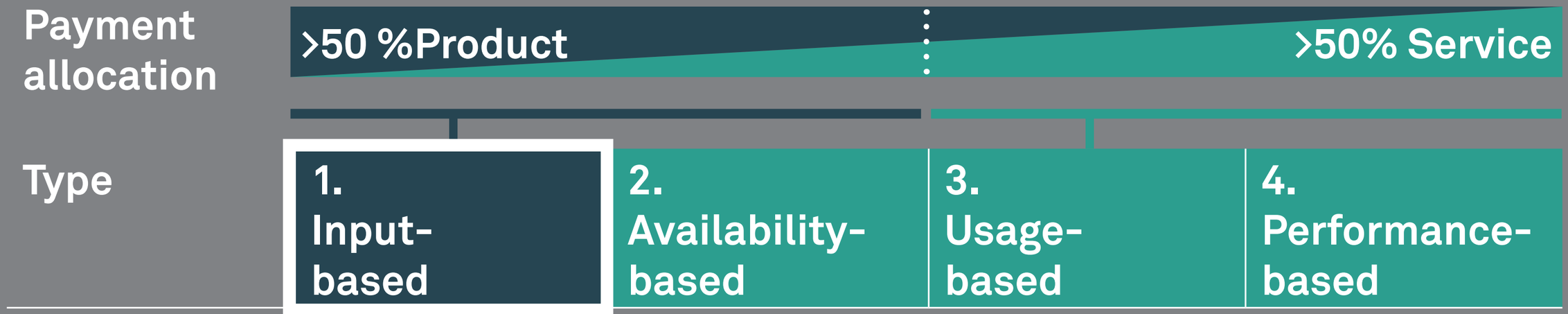
Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

How can PSSs be applied in rental housing?

Payment allocation	>50 %Product			>50% Service
Type	**1. Input-based**	**2. Availability-based**	**3. Usage-based**	**4. Performance-based**
How function is accessed	Purchased	Typically Leased *(purchasing is possible)*		
Payment Delivery	At moment of purchase, & when service is completed	When building component is available for use	When building component is used	When performance criteria is met by building component

Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

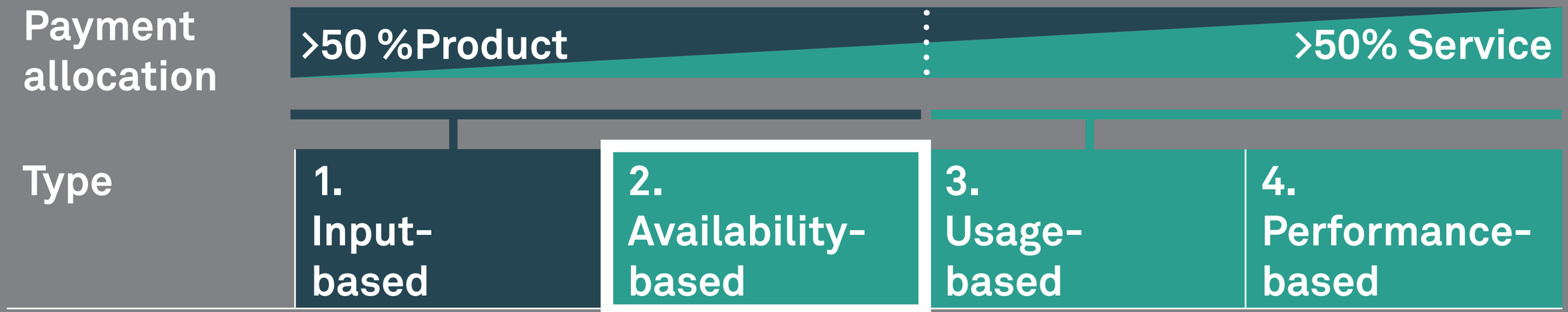
How can PSSs be applied in rental housing?



Purchase

Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

How can PSSs be applied in rental housing?



Lease

Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

How can PSSs be applied in rental housing?

Lease

Taxonomy of PSSs (4 Types); own figure, based on van Ostaeyen et al. (2013)

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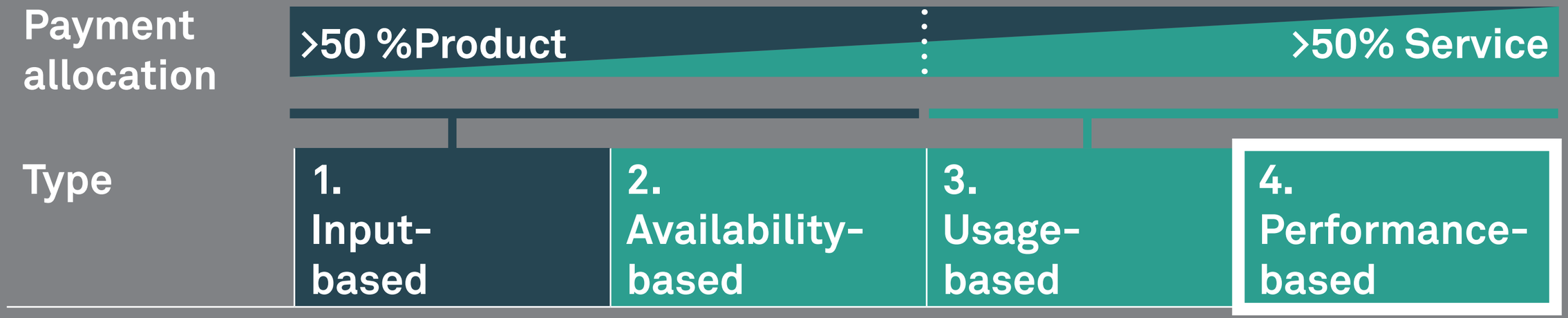

Lease

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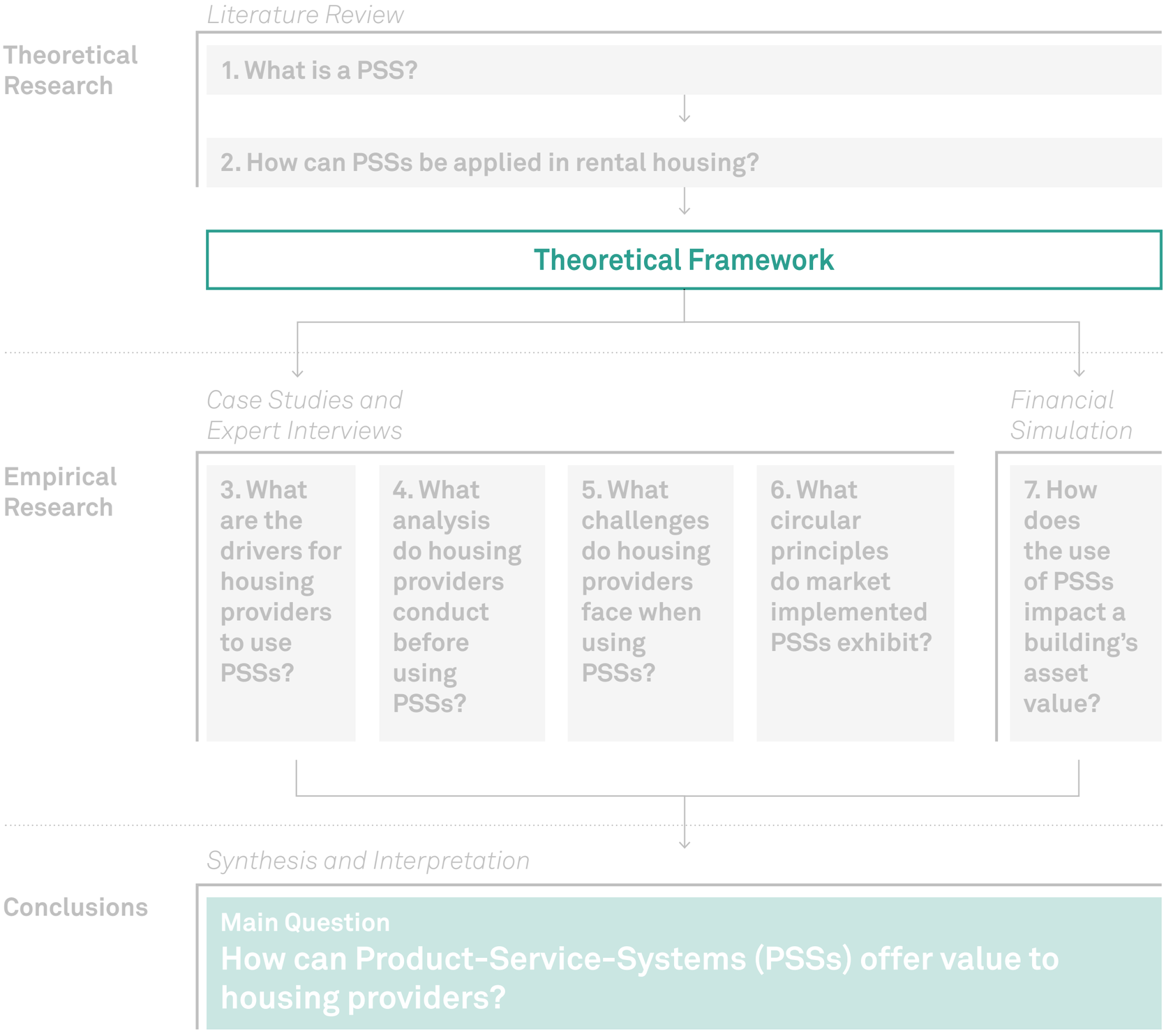
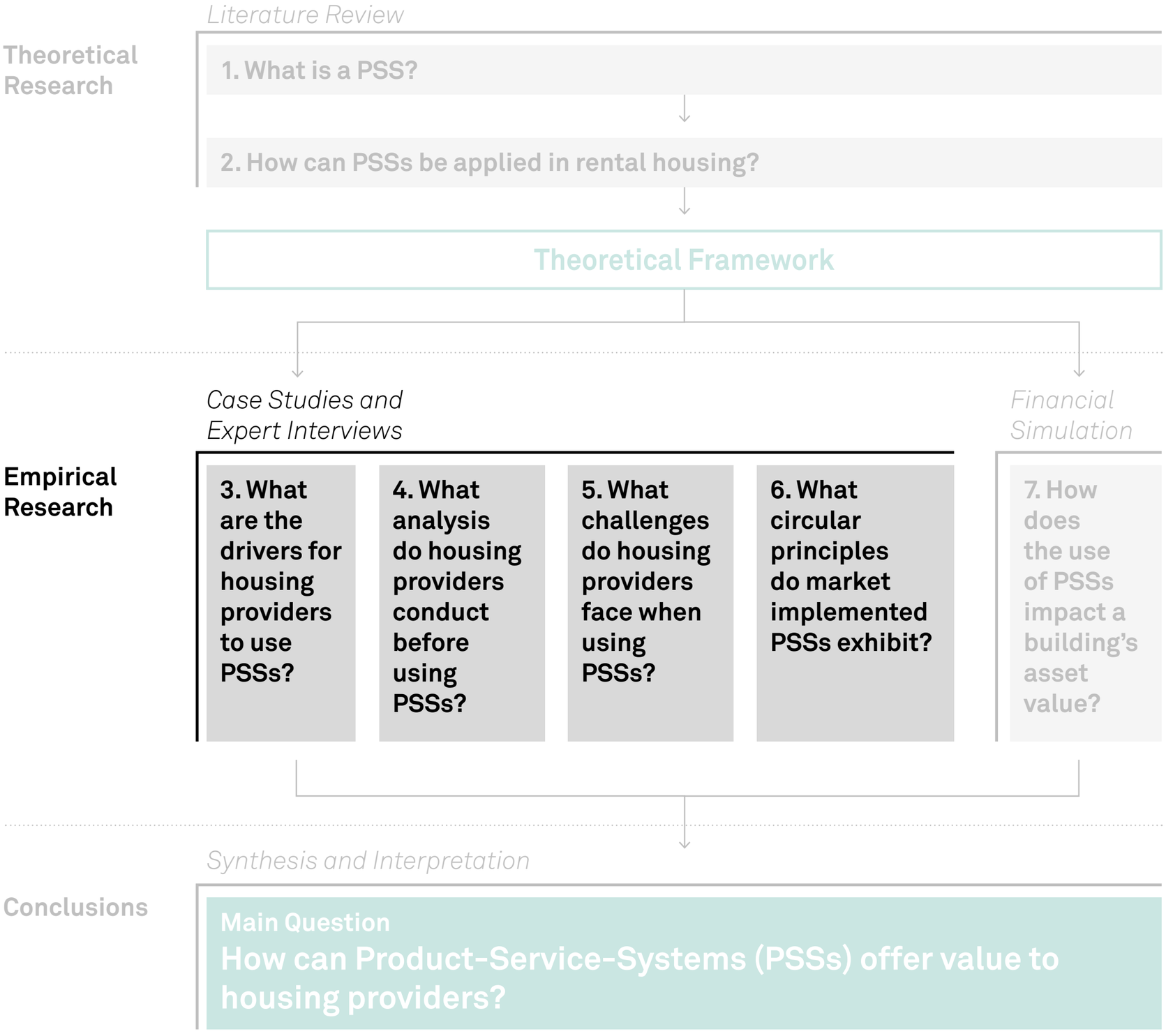
Methodology



Methodology



Empirical Research: 7 Case Studies and 5 Experts in PSSs + Circularity

Case Studies

Purchased

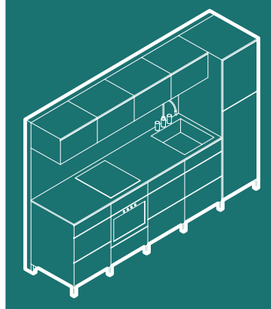
input-based

A
Elevator

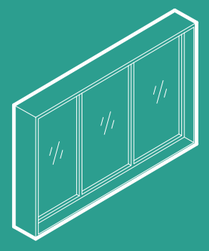
Leased

availability-based

B
Kitchen



C
Window

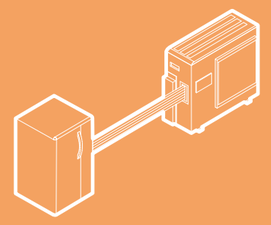


D
Battery

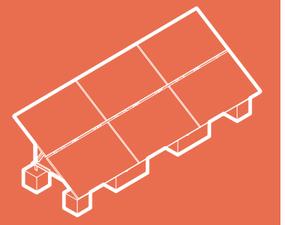
usage-based

E
Elevator

F
Heat Pump



G
PV Panels



Experts

(ABN AMRO)

(TNO)

(Turntoo)

(Een Veilig Gevoel)

(Volantis)

17 semi-structured 1-hour interviews, coded & analyzed in ATLAS.ti

Outsource Risk and Responsibilities

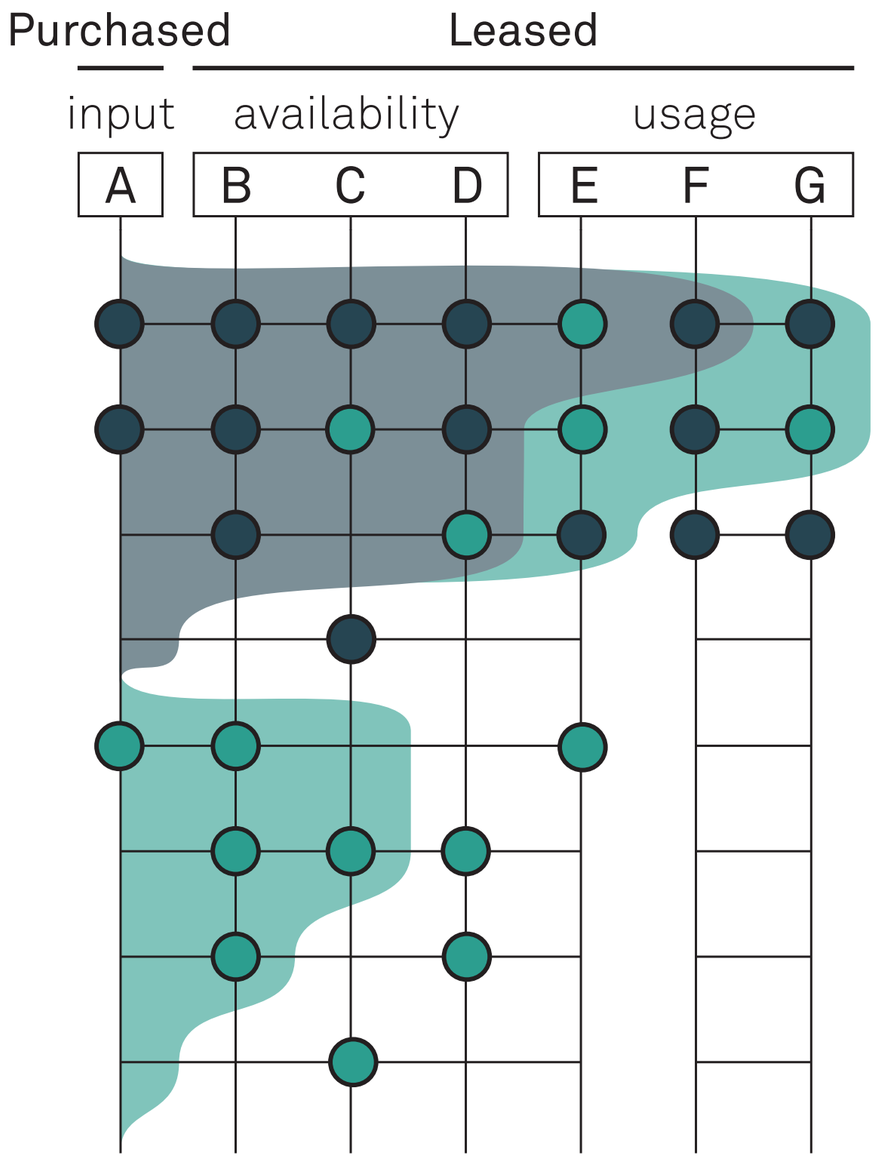
Accomplish (More) Scope without Capital

"Well, for me, the main thing is that it allows me to keep my business lean, so I don't want to expand the business in the sense of employing more people. So this is a very good way to outsource a big part of the technical responsibility while also being able to outsource the management over these assets and the financial investment on these assets. And that last point was especially important for this project, because transforming buildings is already very complex with many moving parts during the decision making process. And that's even worse in the case of old buildings, especially monuments where you have a lot of restrictions. So the PSS alternative to the kitchens came as a good way of releasing some pressure on the budget."

- Case B: HP

What are the drivers for housing providers to use PSSs?

● **Primary Driver**
● **Secondary Advantage**



Concepts Identified

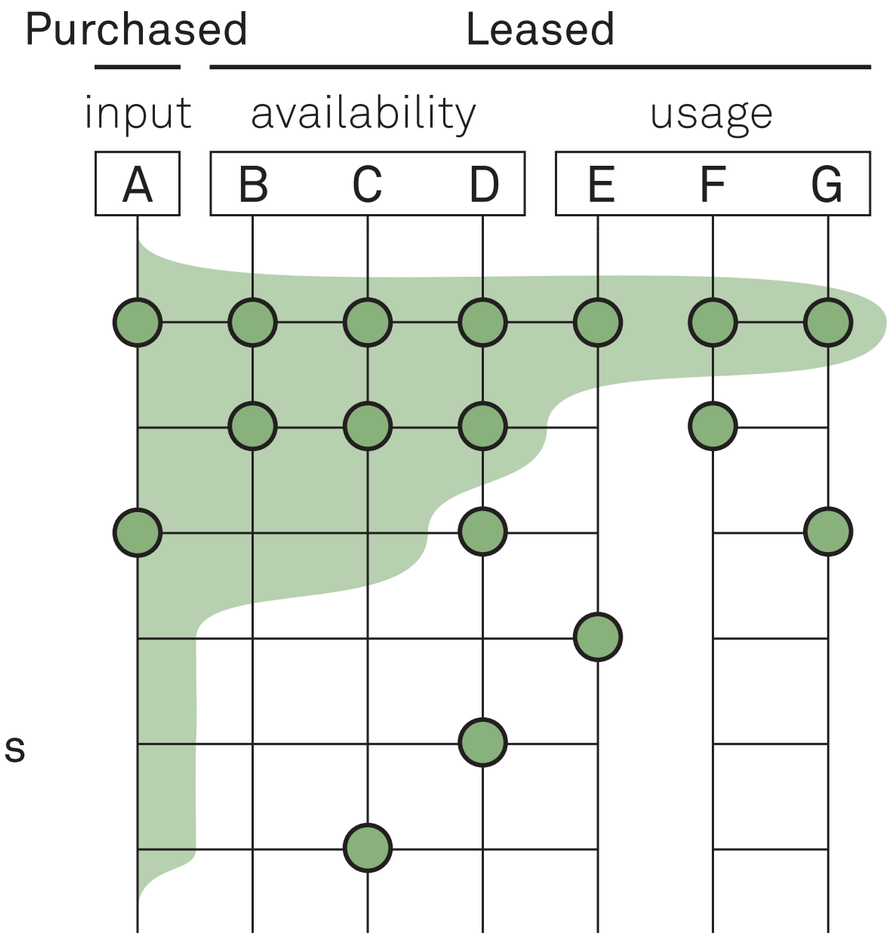
- Achieve long-term cost savings
- Outsource risk and responsibilities
- Accomplish (more) scope without capital
- Prepare for changing regulations
- Establish predictable costs
- Enhance portfolio circularity
- Enhance market appeal
- Enhance building flexibility

What analysis do housing providers conduct before using PSSs?

Analysis

Concepts Identified

- Financial
- Risks and responsibilities
- PSSP historic service performance
- PSS impacts on resident service costs
- PSS impacts on future building operations
- End-of-use scenarios



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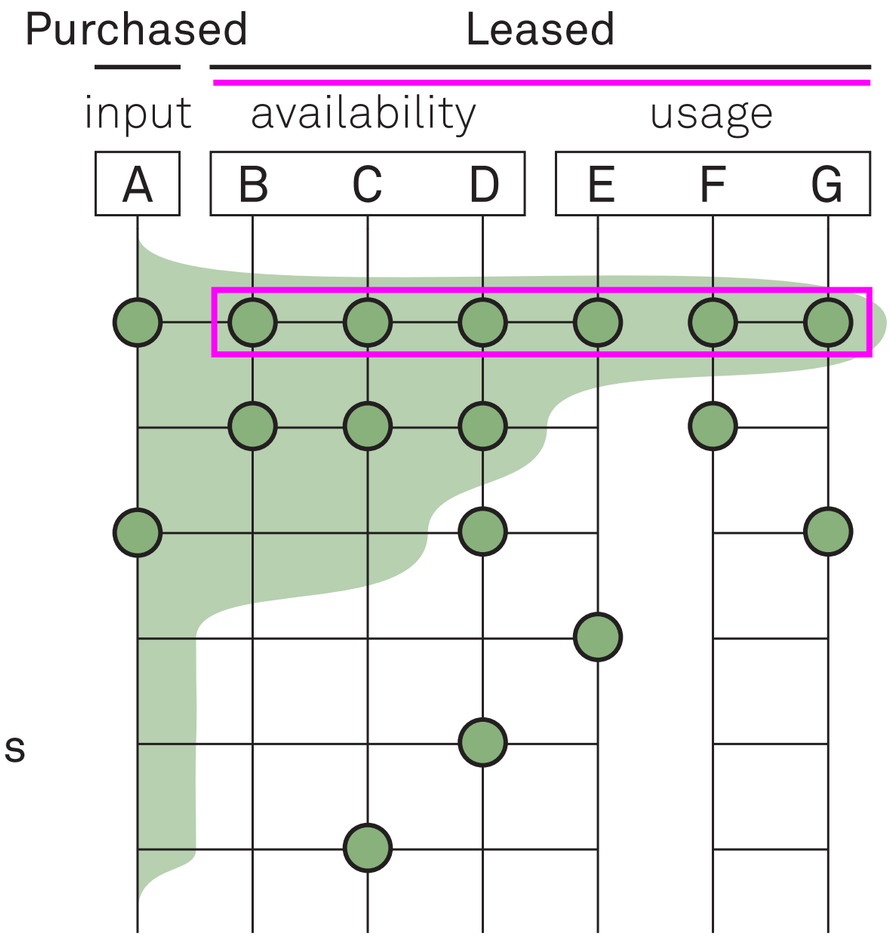


% cost savings

Total Cost of **<u>Use</u> (TCU)** *vs* Total Cost of **<u>Ownership</u> (TCO)**

What challenges do housing providers face when using PSSs?

Challenges

Concepts Identified

Lack of confidence in PSS/PSSP

Contract complexity

PSS impact on General Contractor’s profit

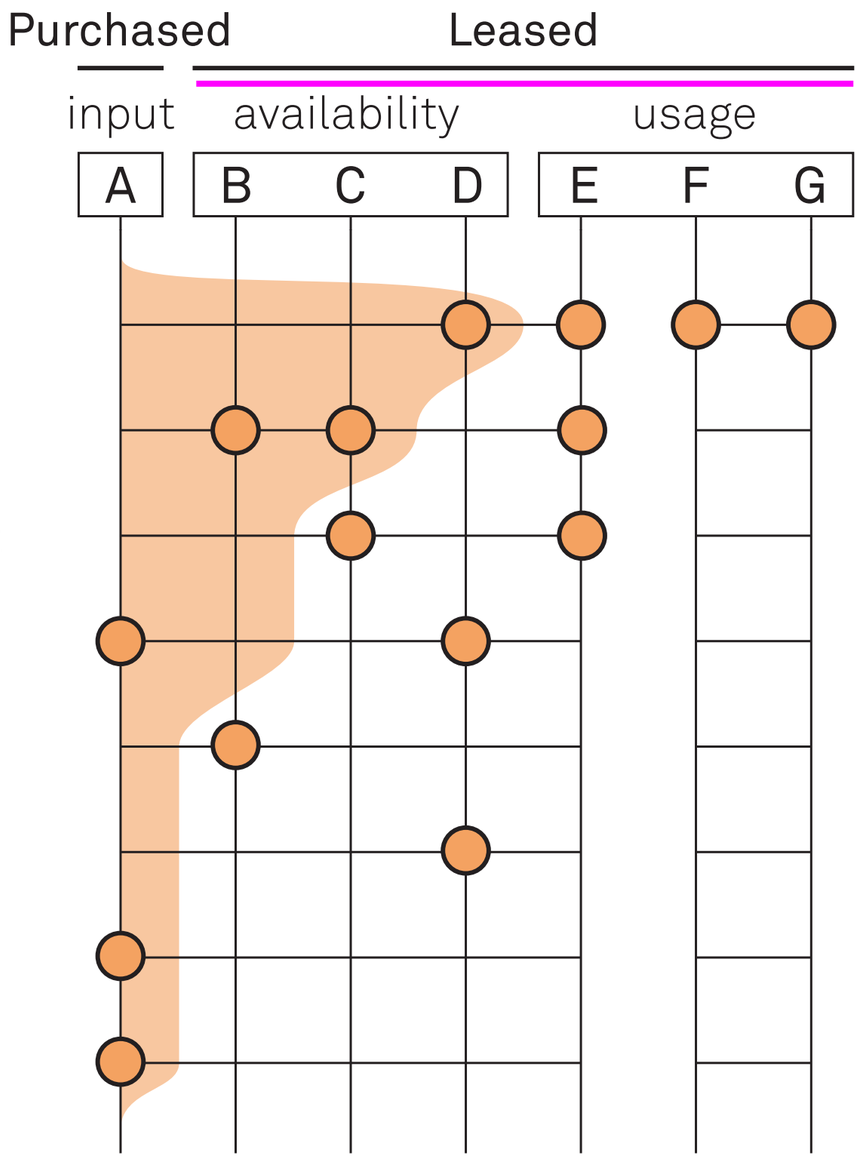
Demarcation of PSS

Product inflexibility

Contract inflexibility

Dissatisfactory service

Incomplete service coverage
(unpredictable costs)



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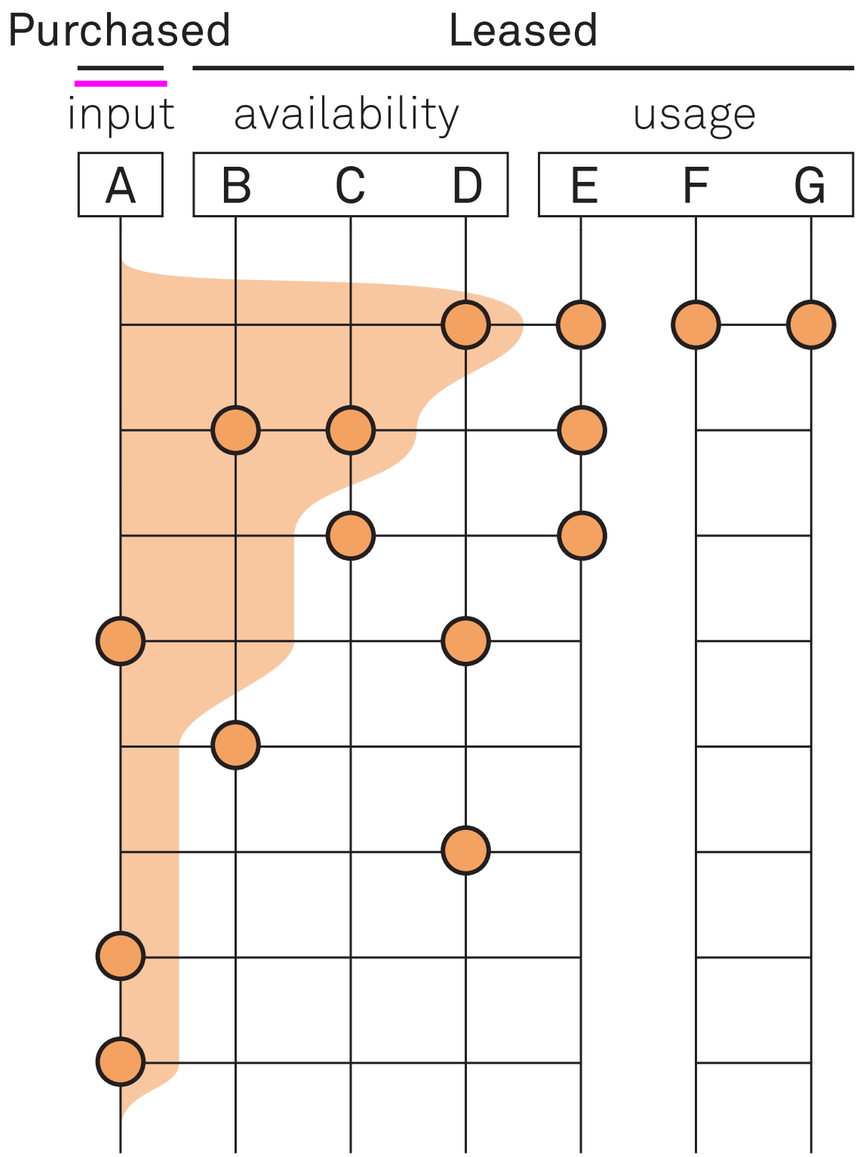


What circular principles do market implemented PSSs exhibit?

Circular principles

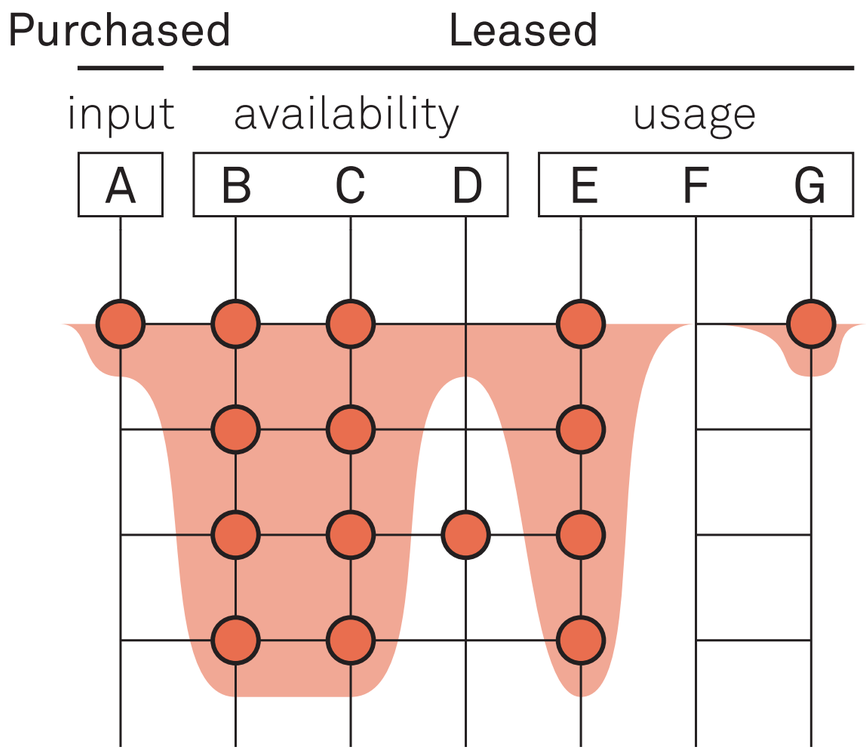
Principles Identified

Product: slowing loops
Long life

Product: closing loops
Designed for disassembly and reuse

Business model: slowing loops
Exploiting residual value

Business model: closing loops
Using circular inputs



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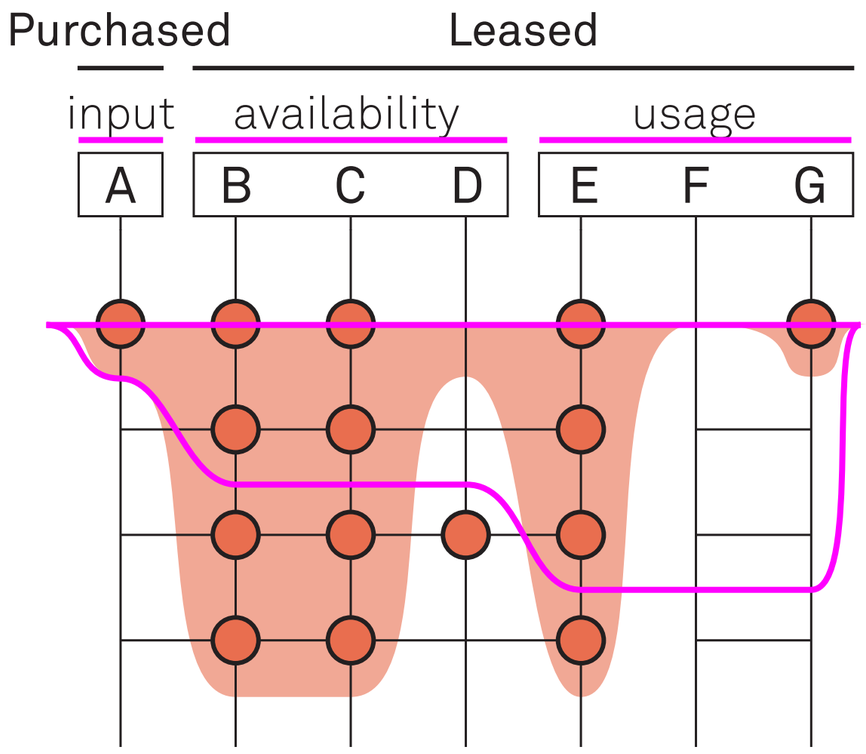
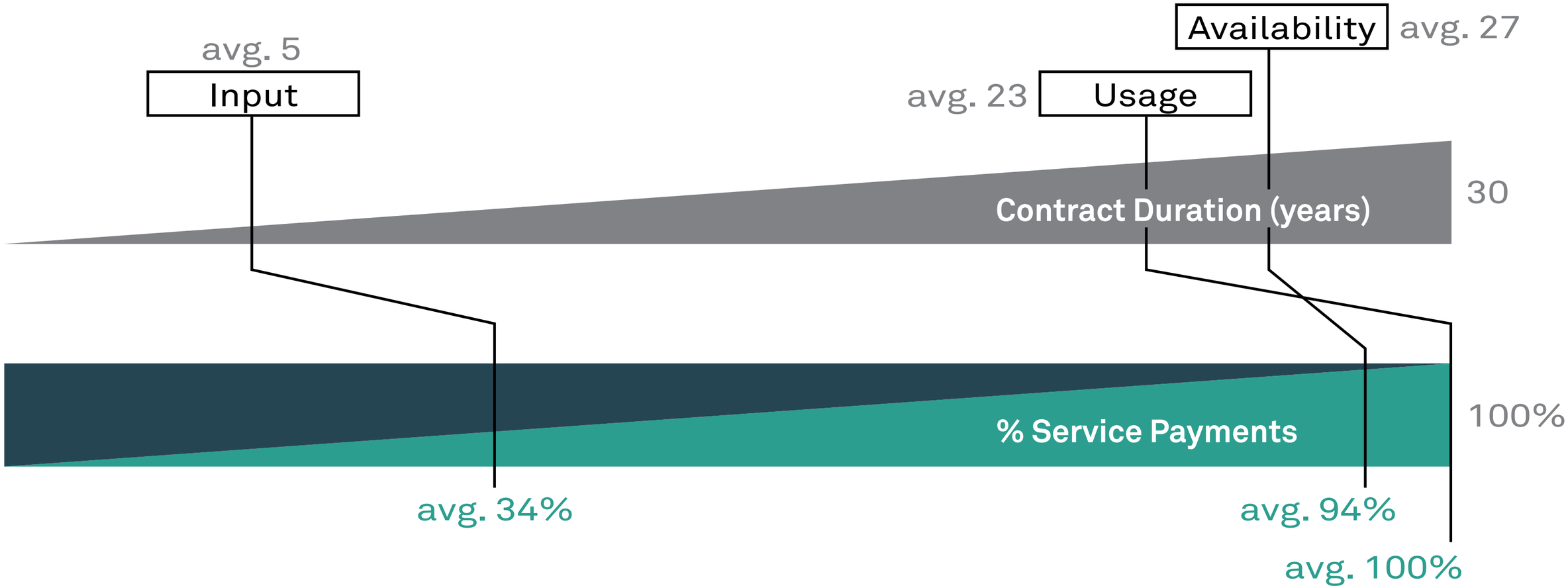


Incentives for satisfactory service



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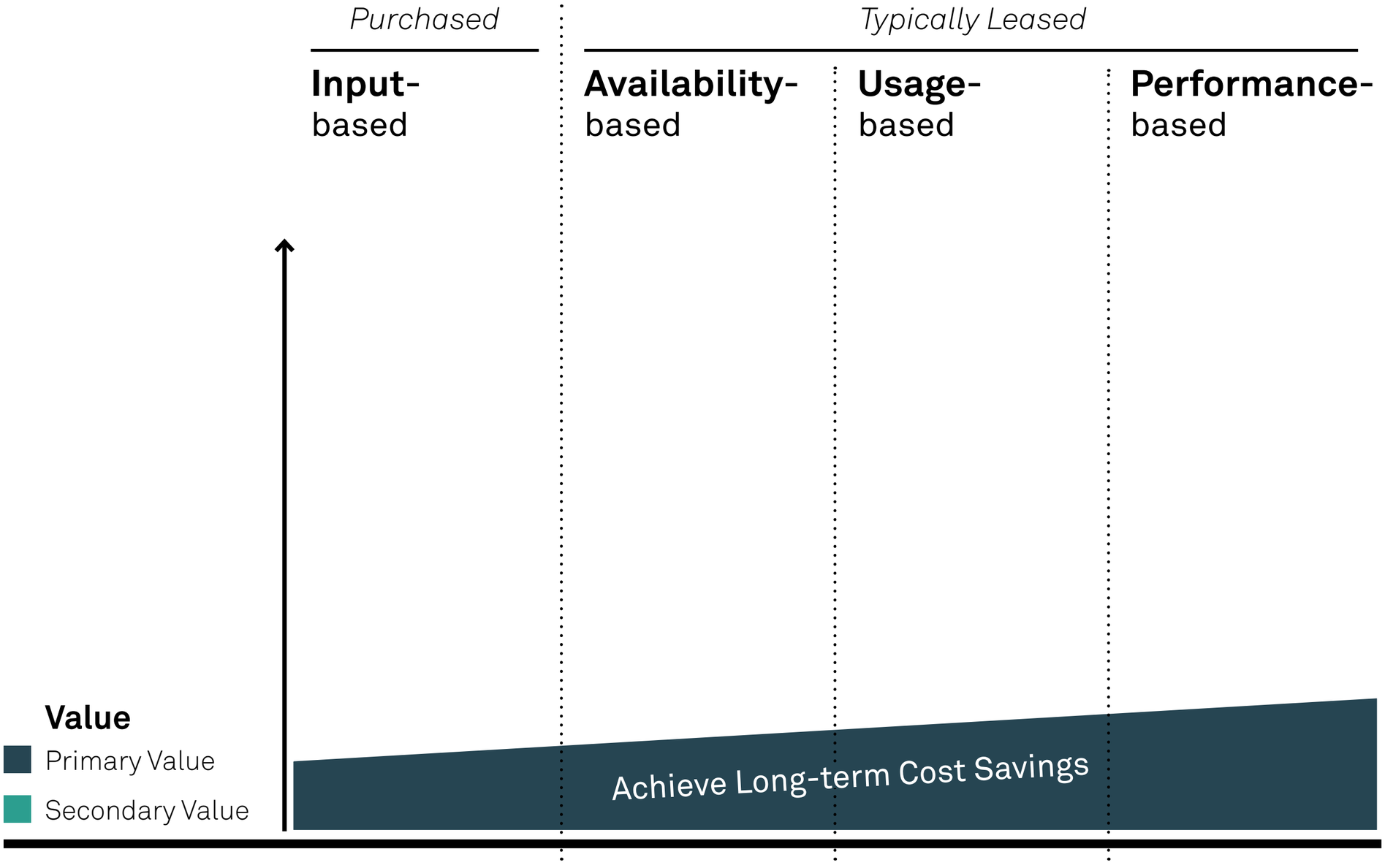

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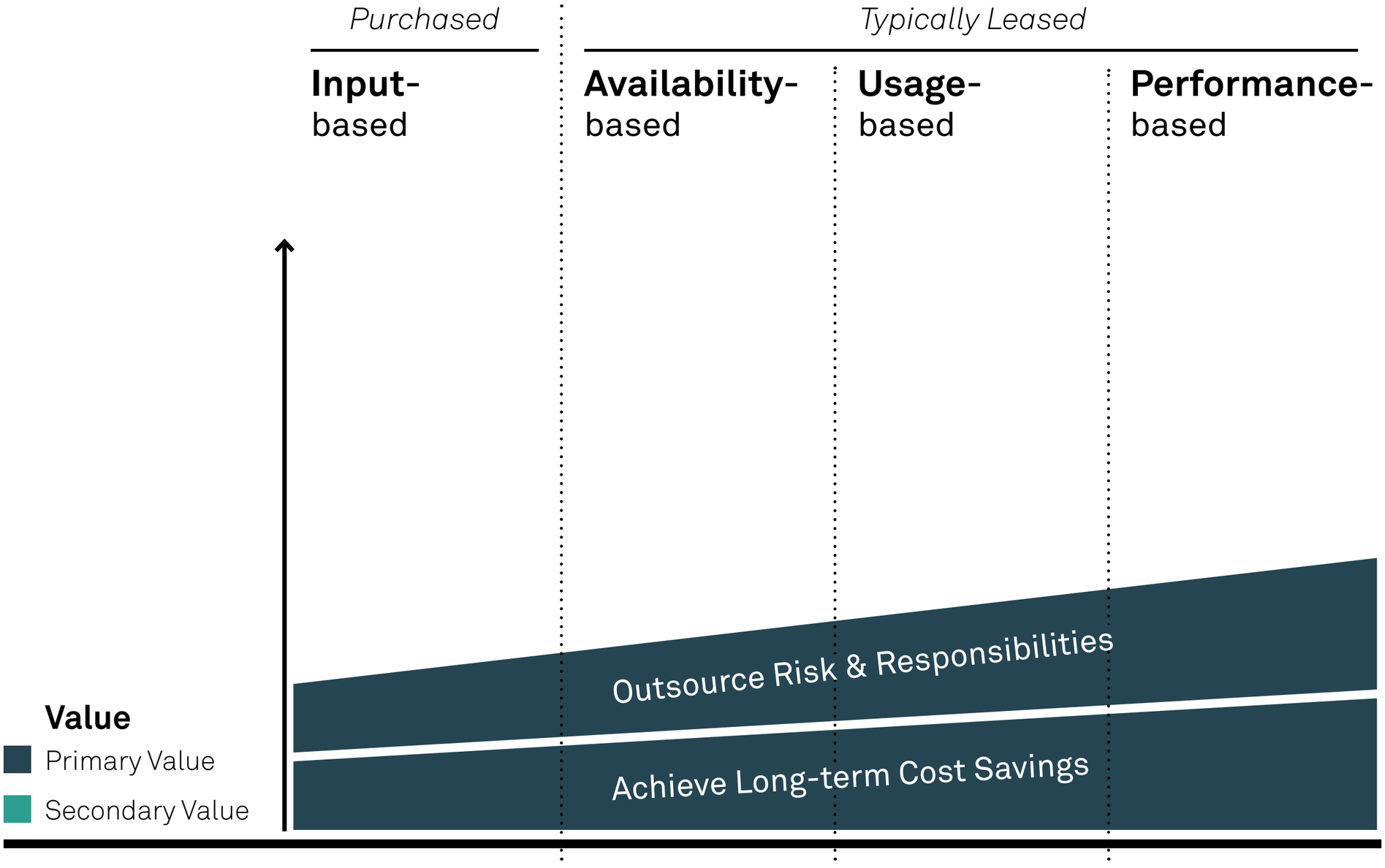

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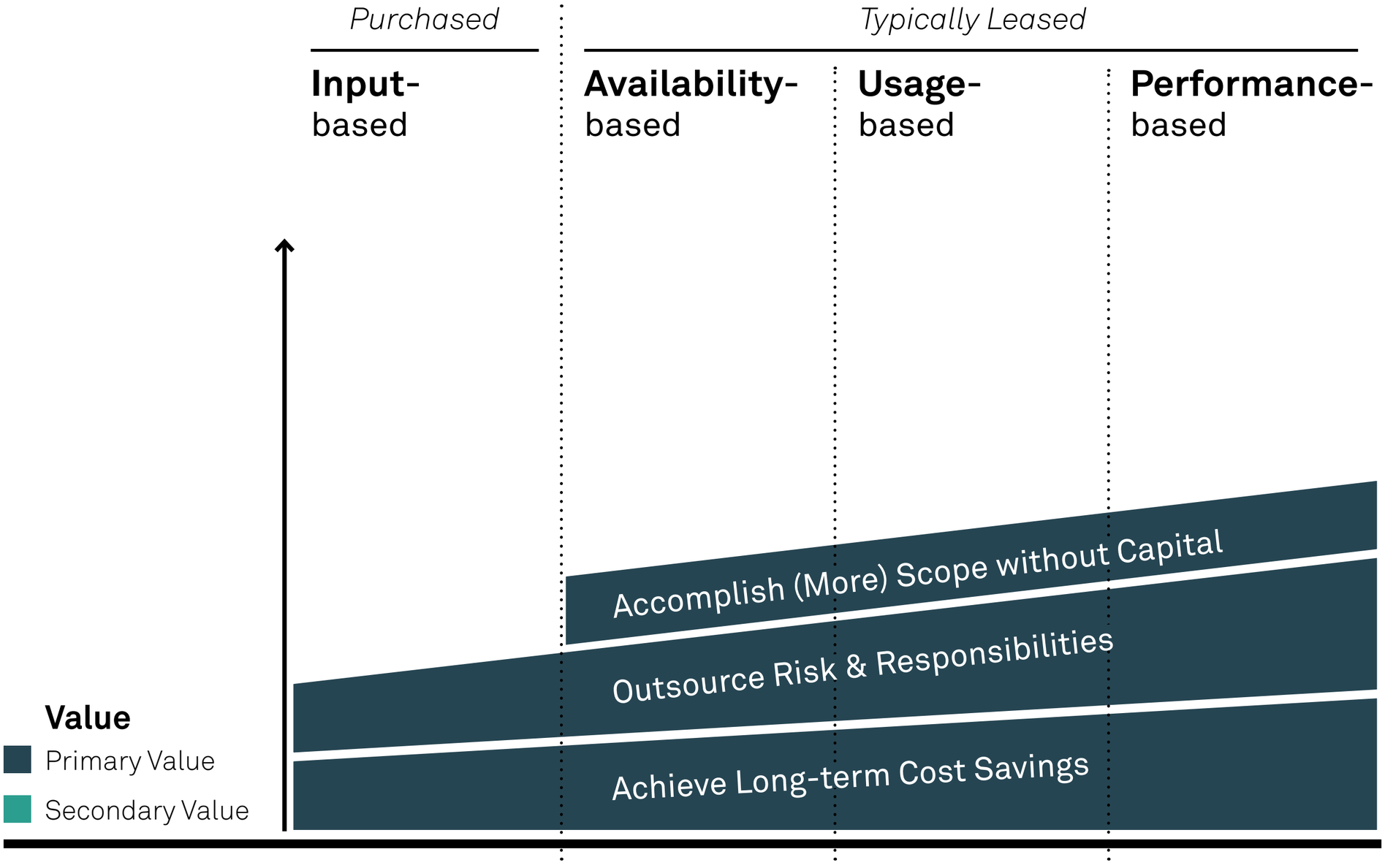

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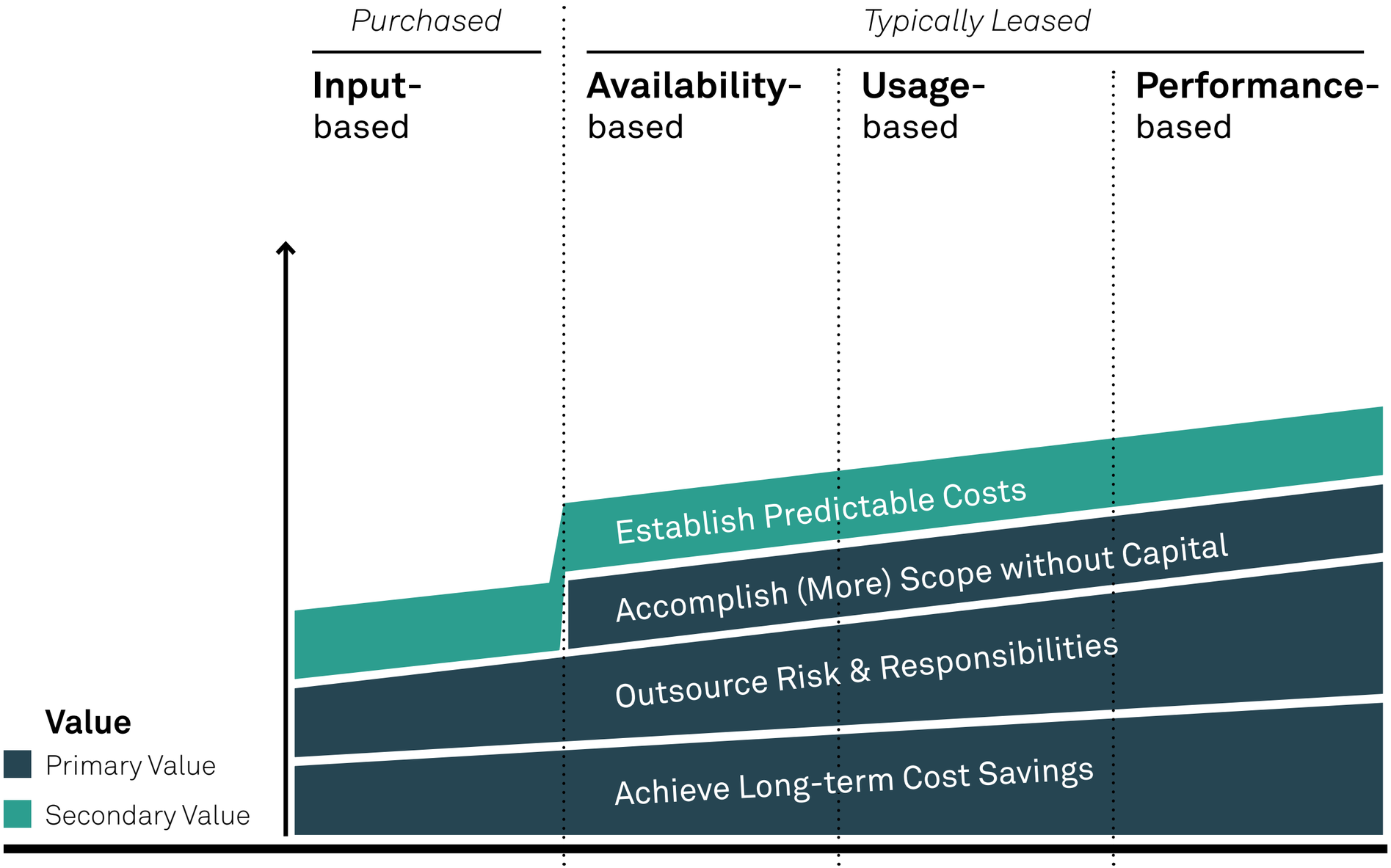

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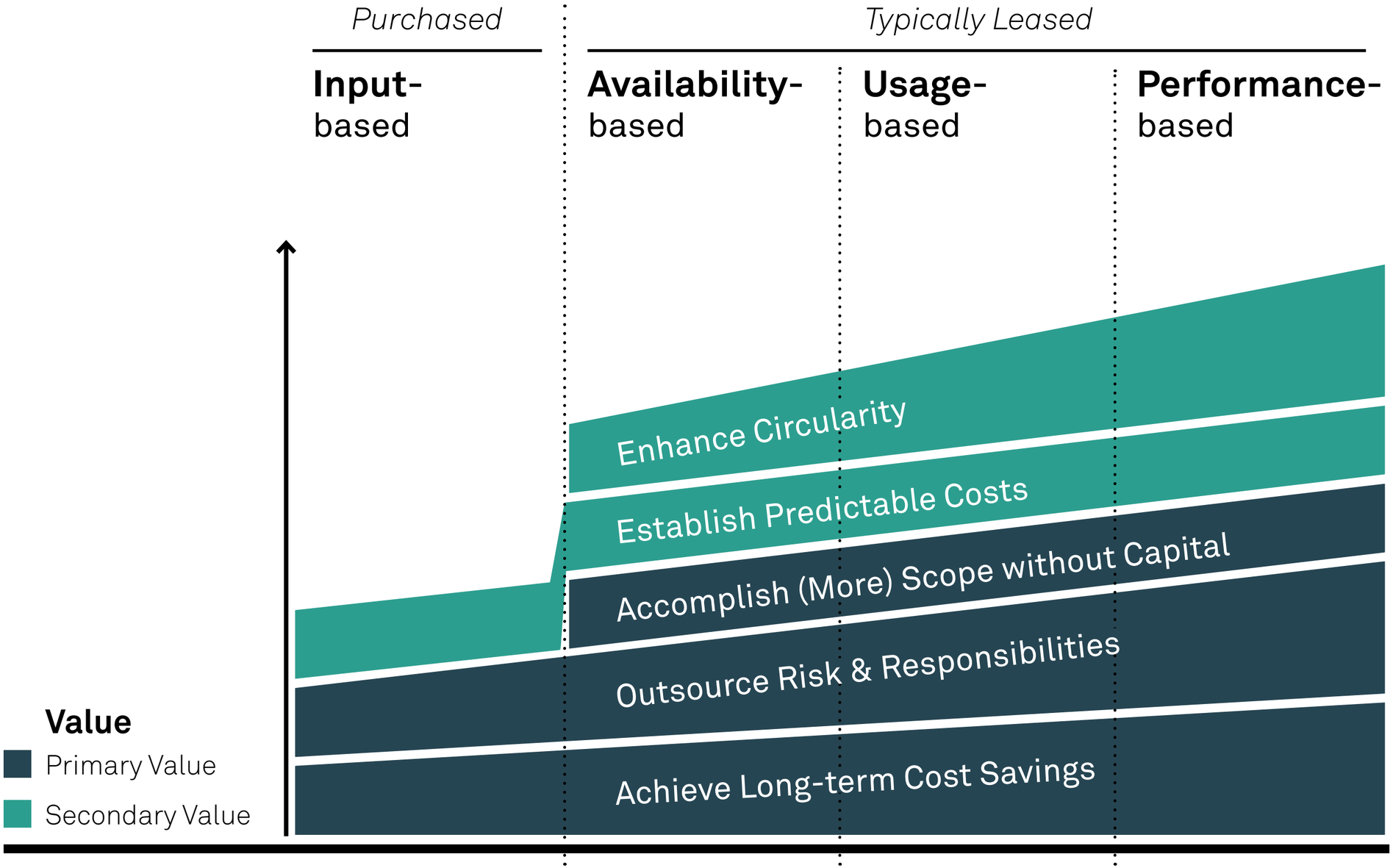

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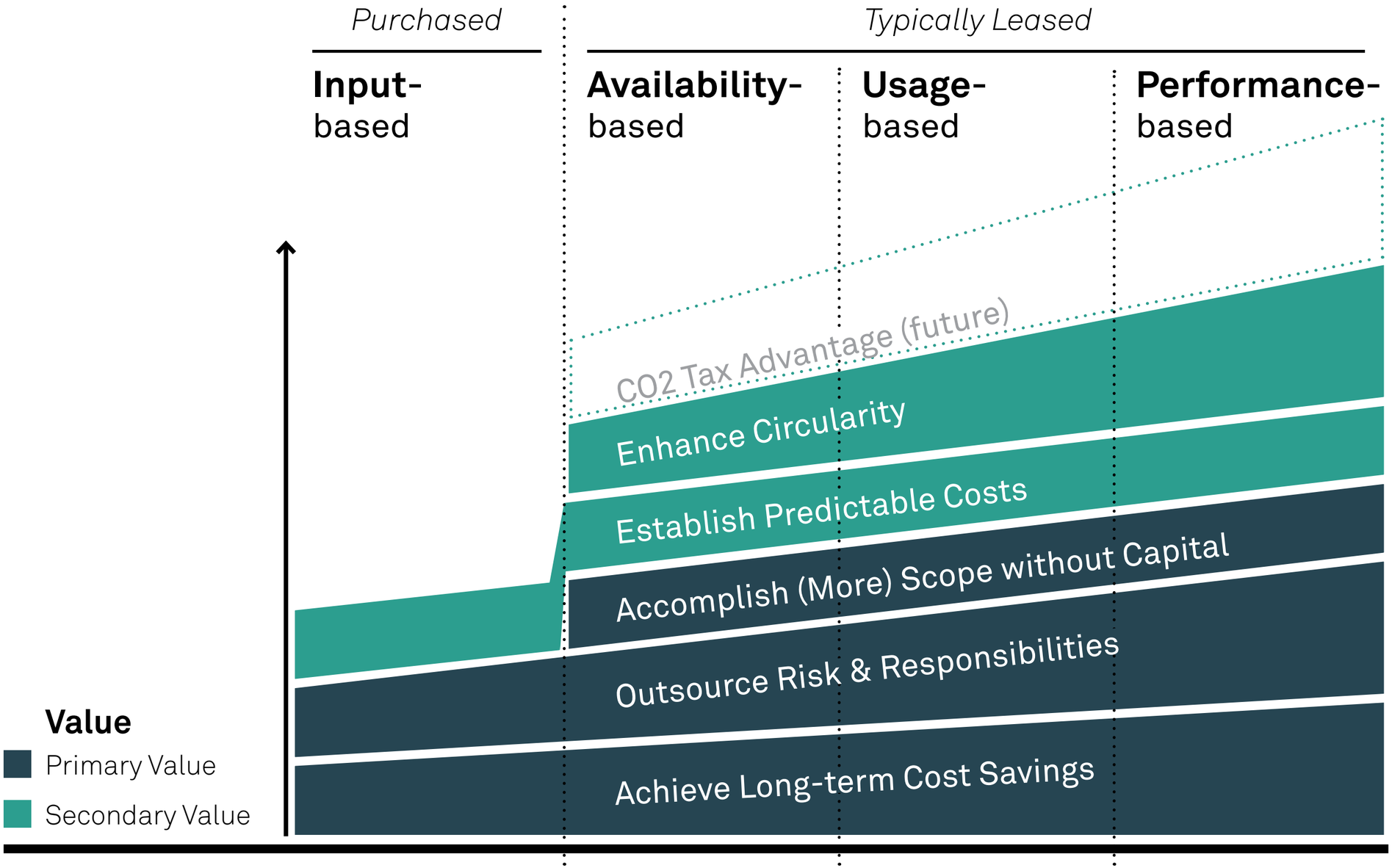
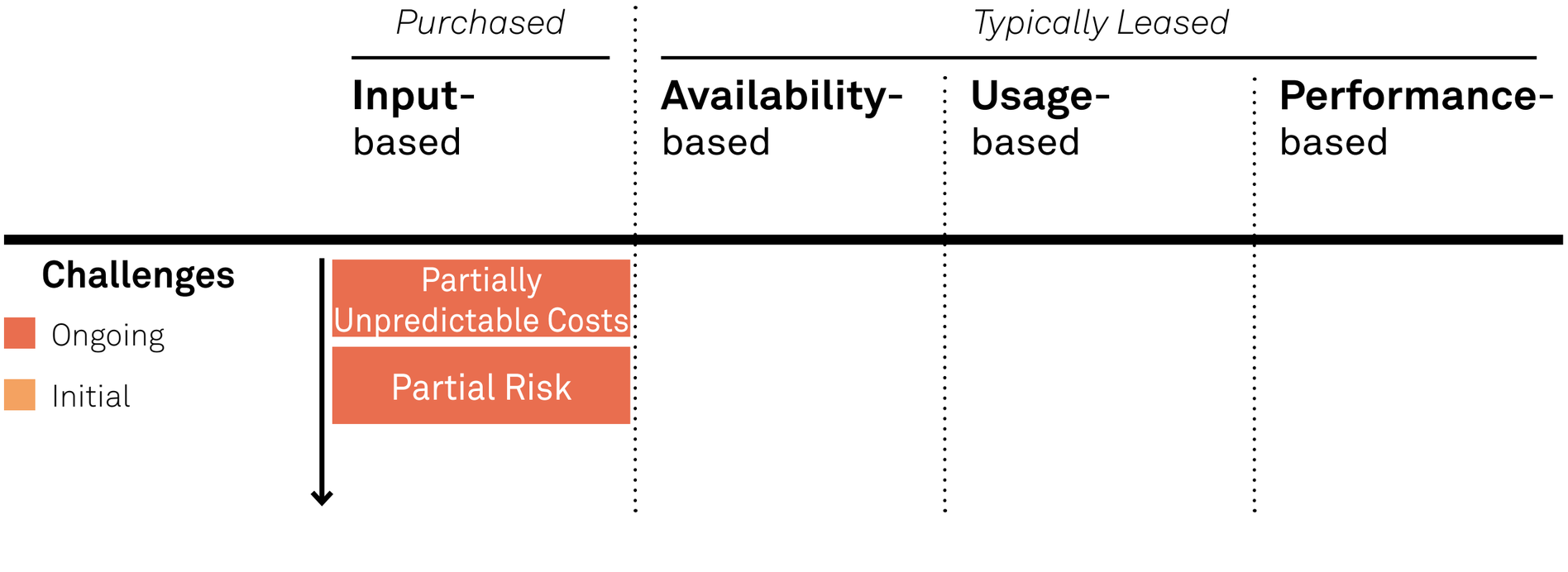
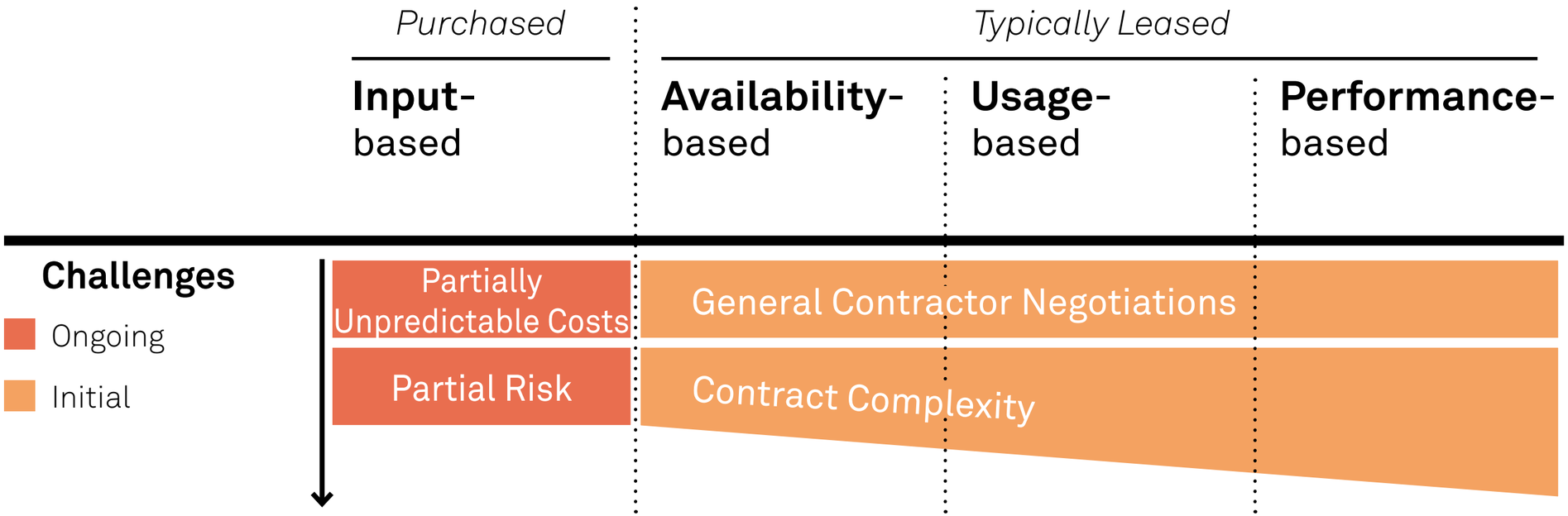


Challenges Faced



Challenges Faced

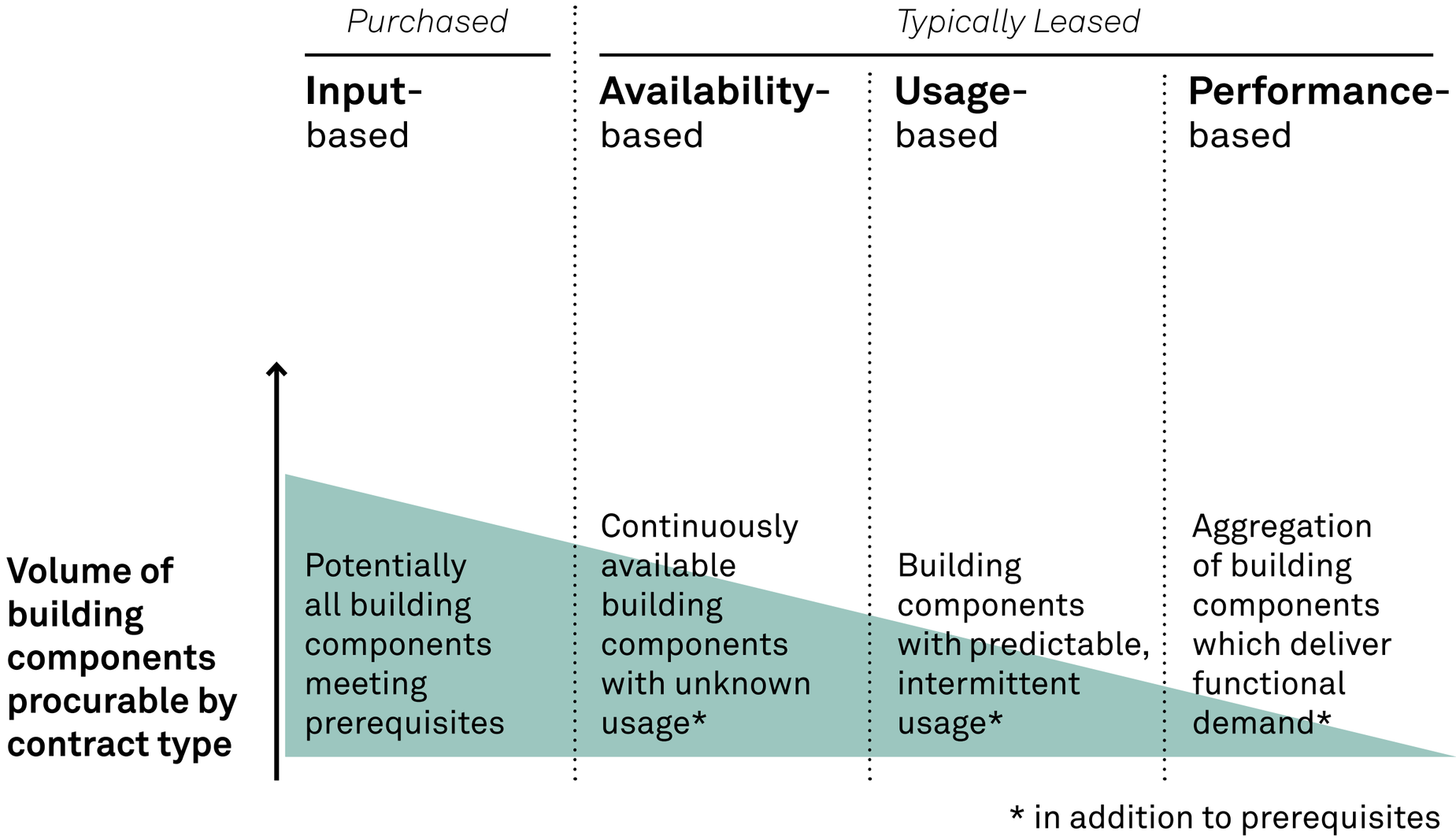


Building component prerequisites

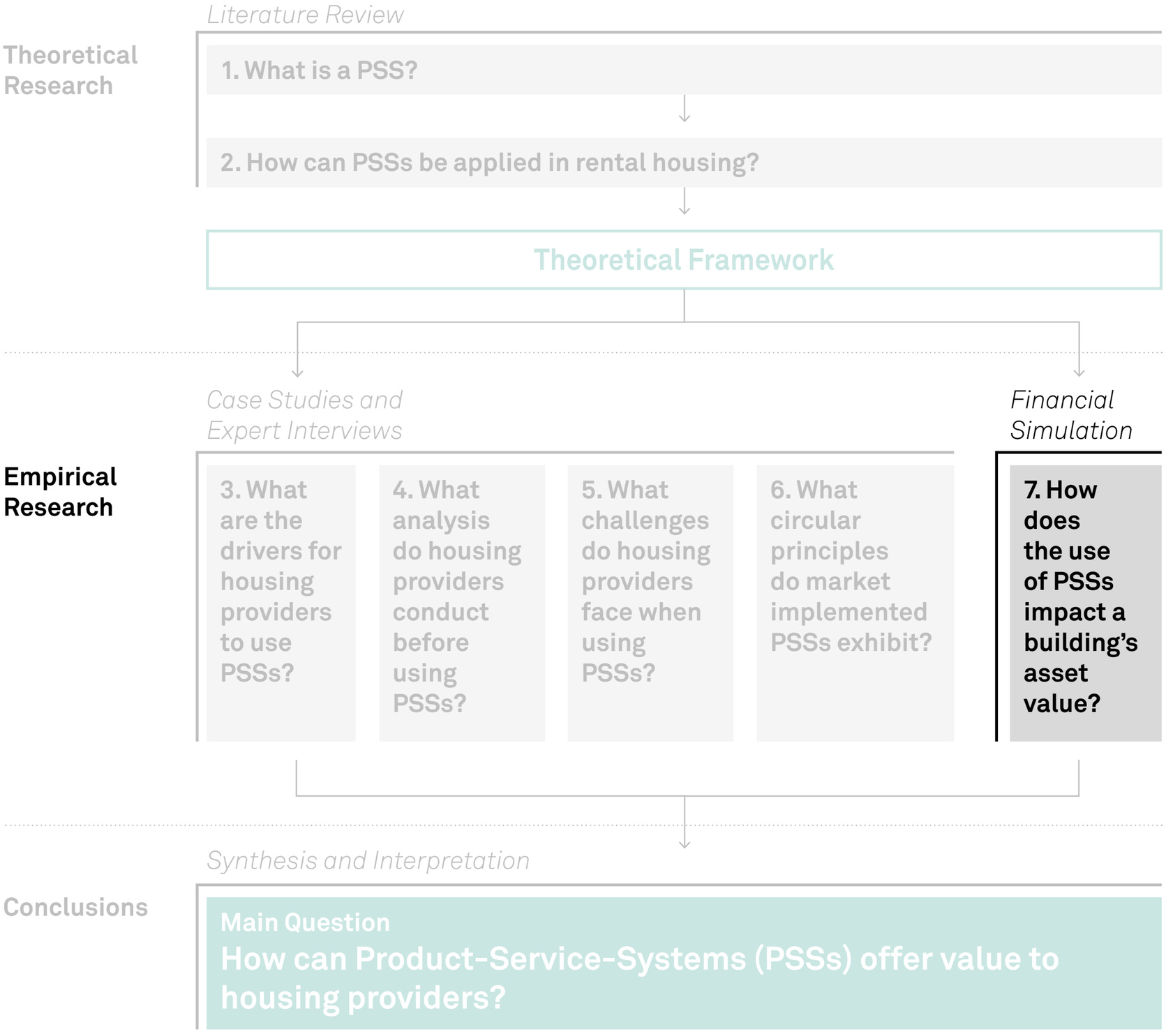
Theoretical	1) intensive maintenance or frequent replacement, 2) inspection or monitoring 3) replacement before exceeding technical lifespan
Empirical	4) advanced expertise to operate at promised efficiencies 5) large CO2 tax payments (when CO2 taxes are established)

Building component's applicability to PSS business model; own figure based on Raposo et al. (2013), Kim et al. (2016), (A. F. Thomsen & Straub (2018), TU Delft (2020)

Applicability



Methodology



How does the use of PSSs impact a building's asset value?

"What I think, is that it will certainly not influence the value of your building negatively. So, it will probably be positive."

— Expert 2 Mark van Ommen (TNO)

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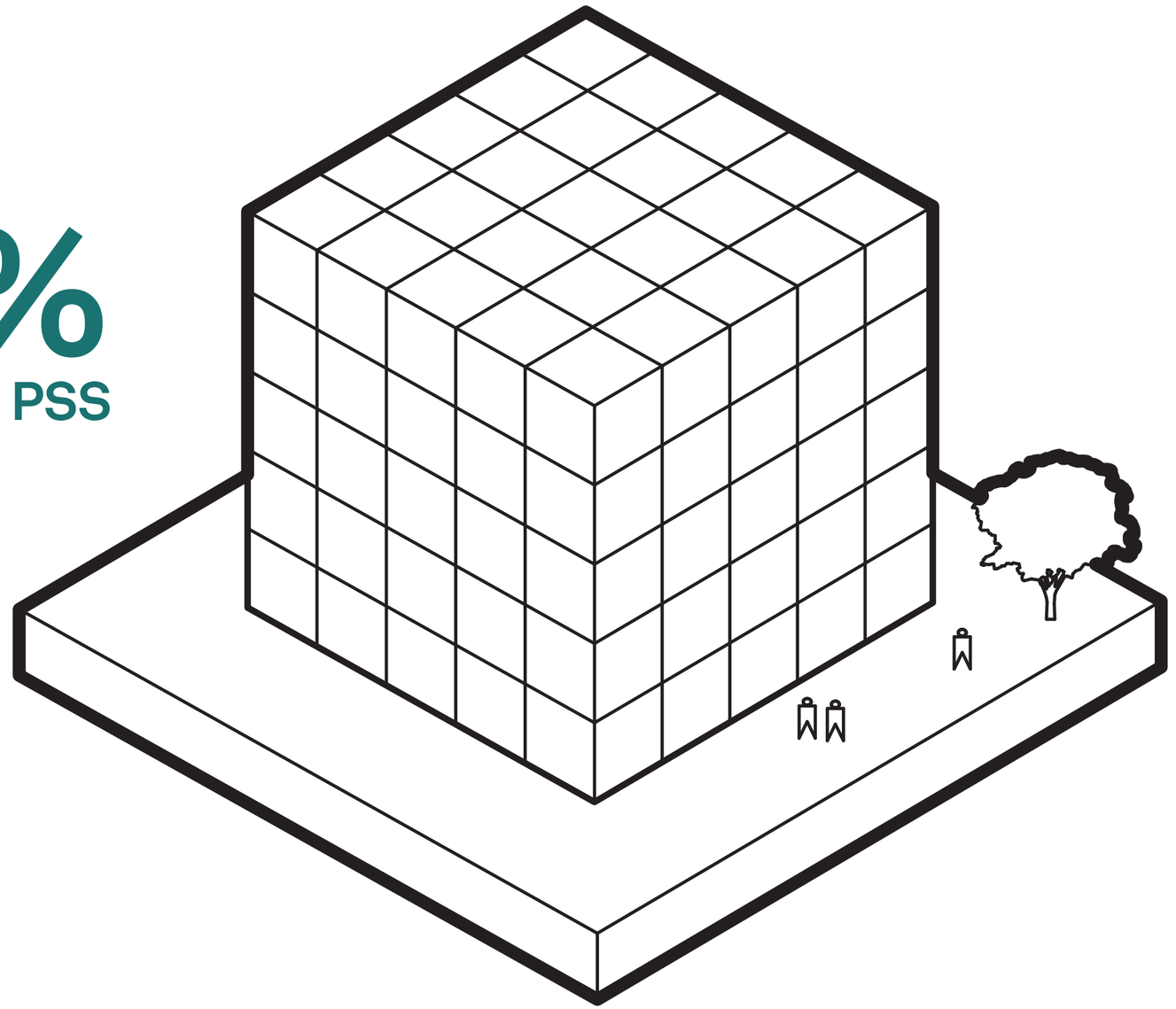
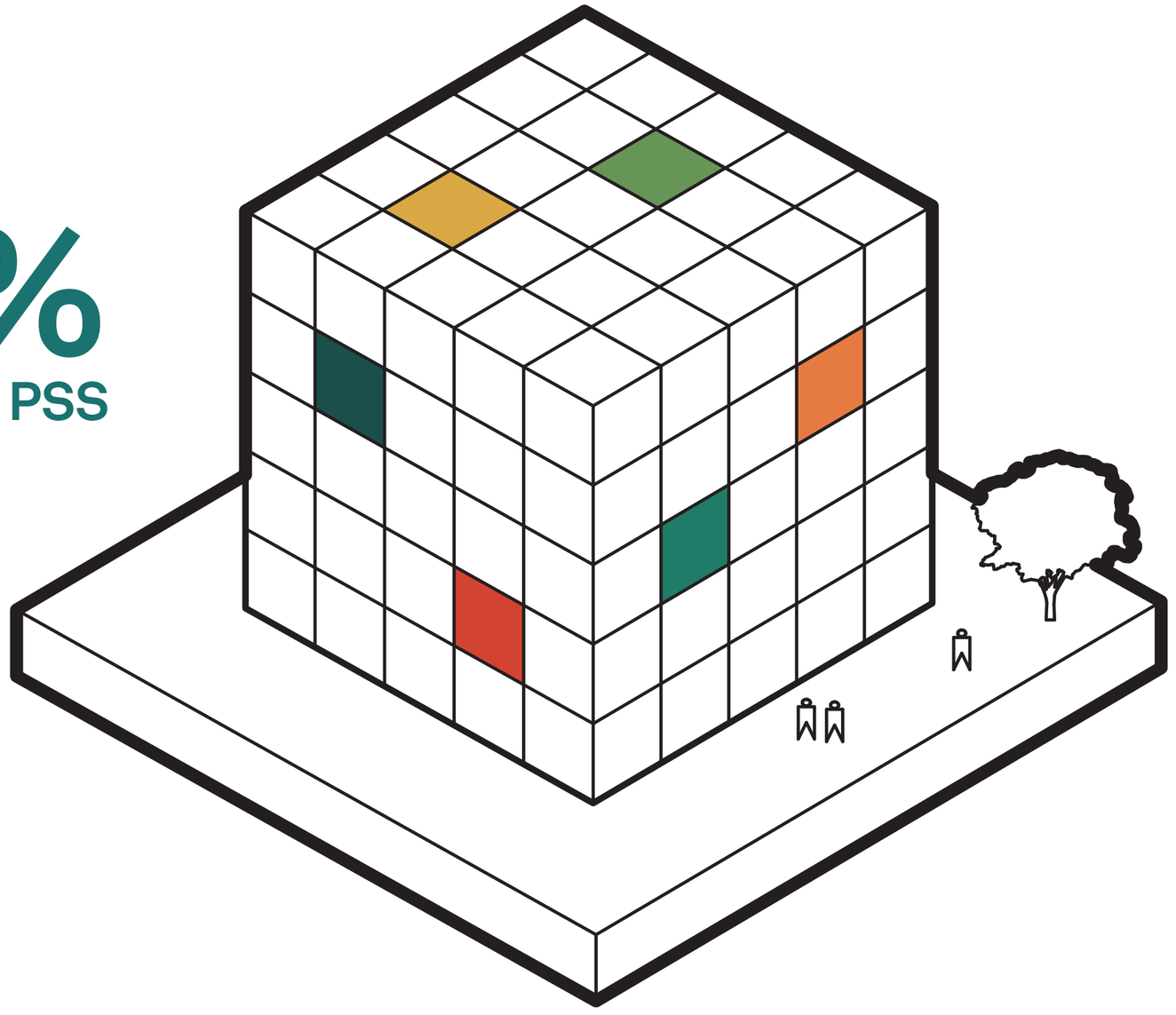
... therefore tax implications of leasing were studied...

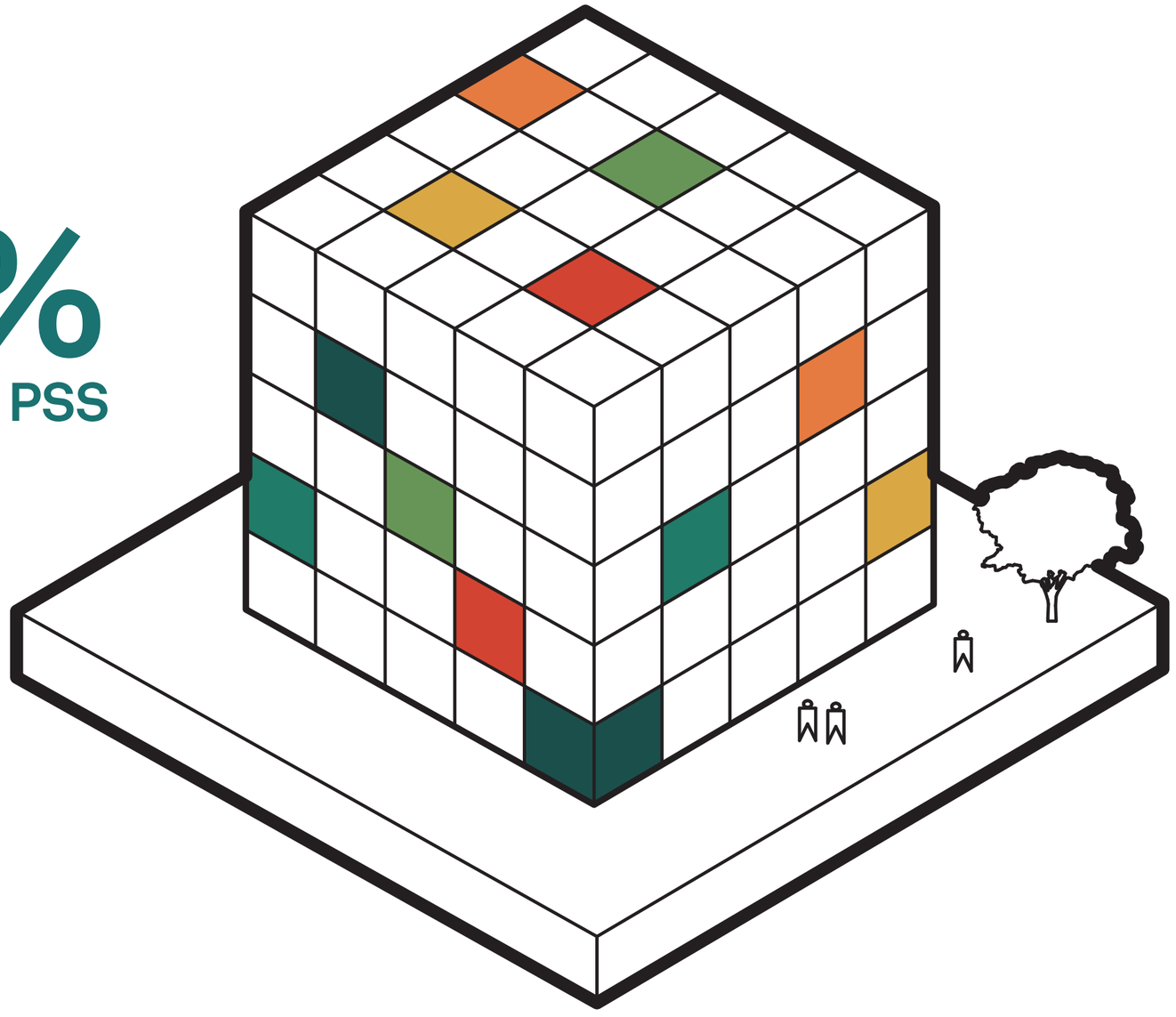
0%
PSS



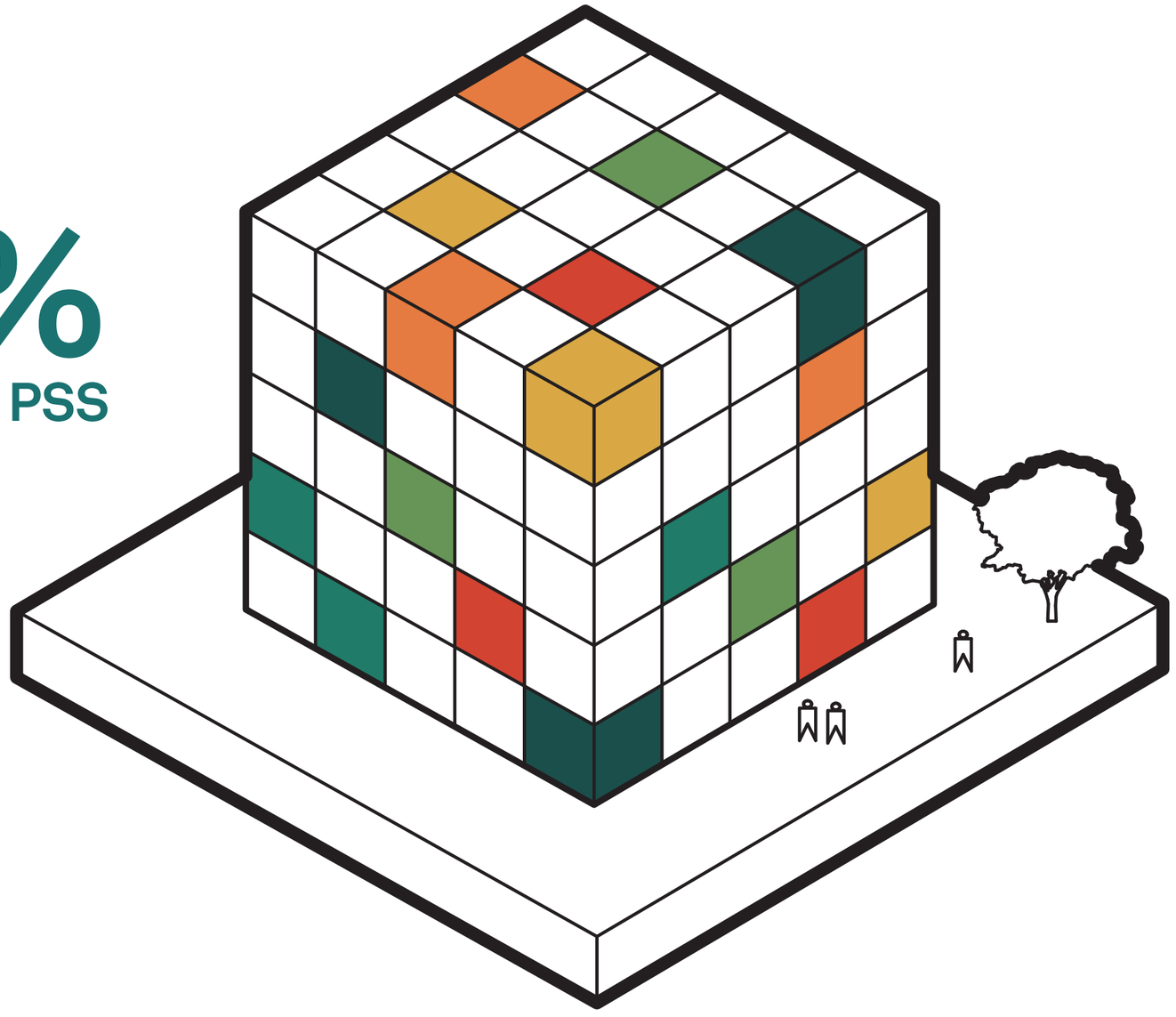
10%
PSS



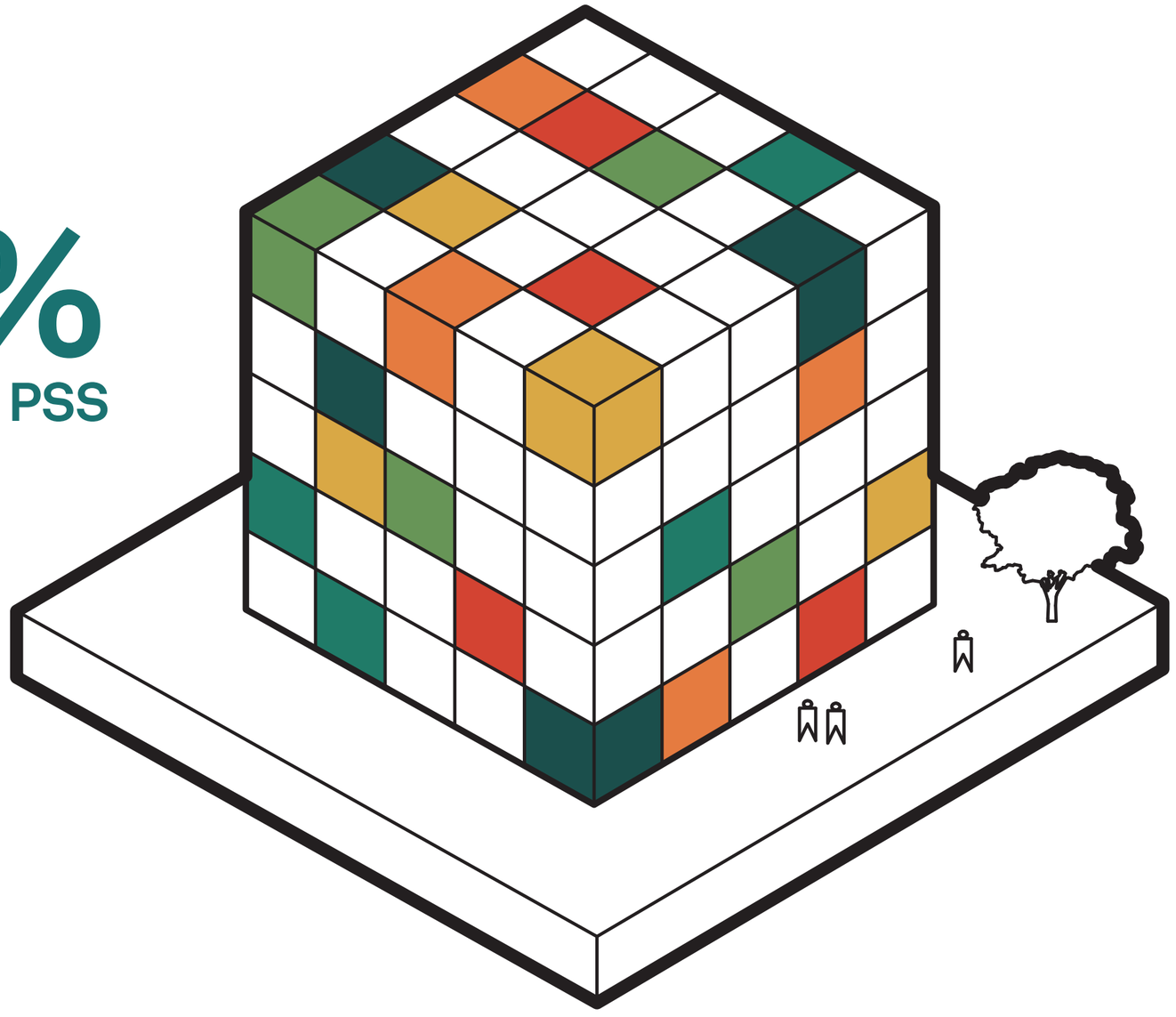
20%
PSS



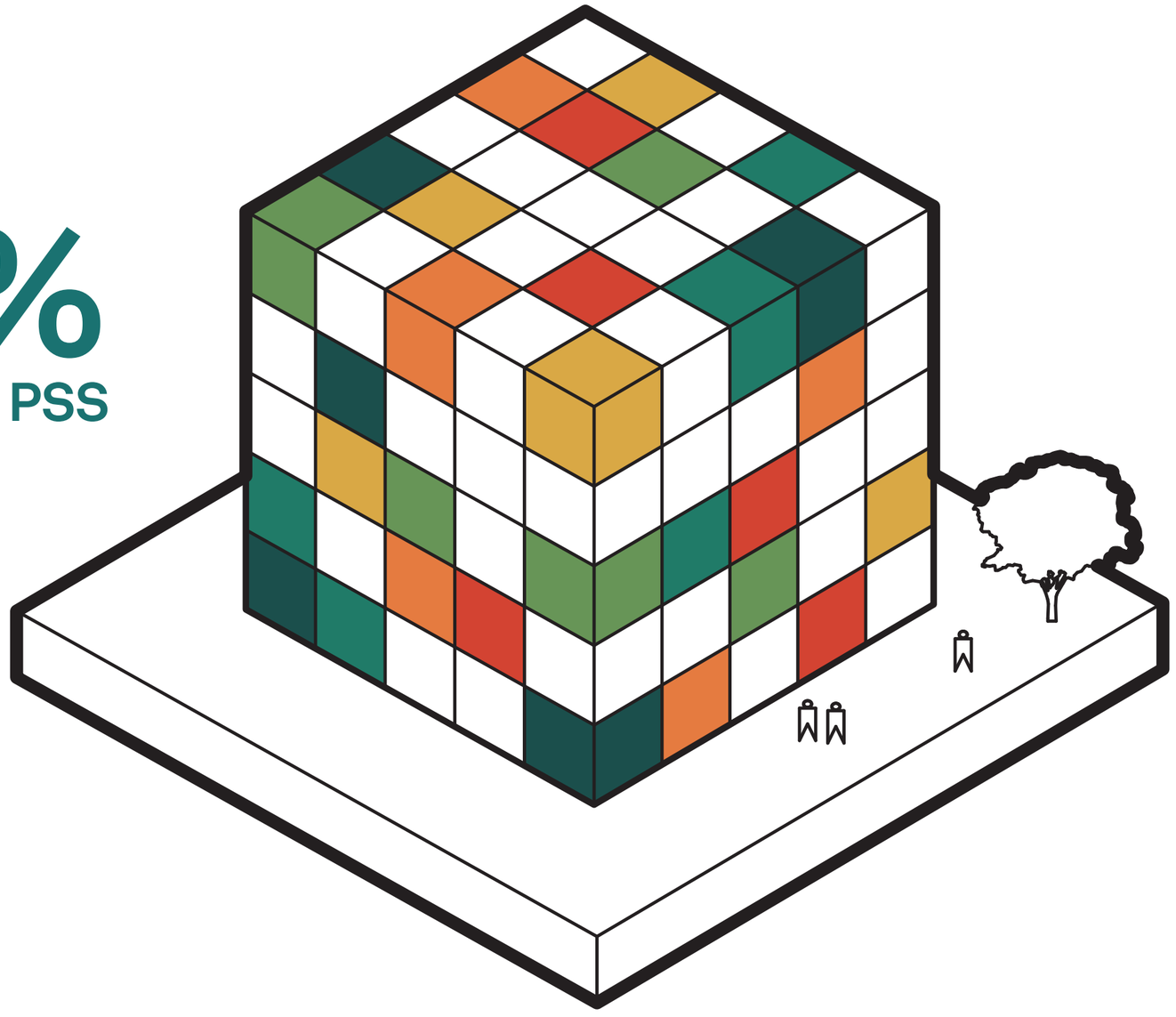
30%
PSS



40%
PSS

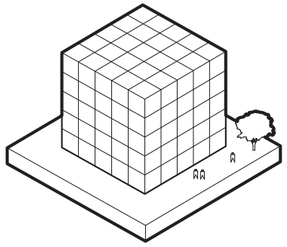
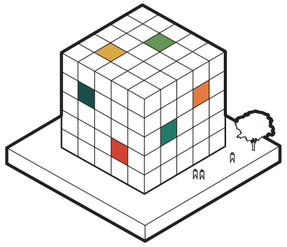
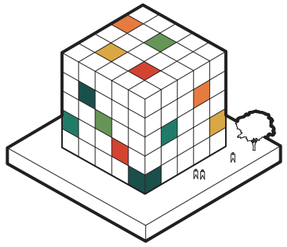
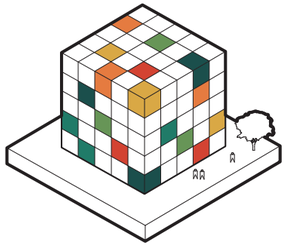
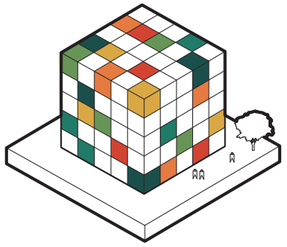
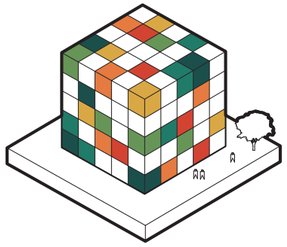


50%
PSS



Financial Simulation (Market-Rate Housing)

All Scenarios: €10 million building is constructed

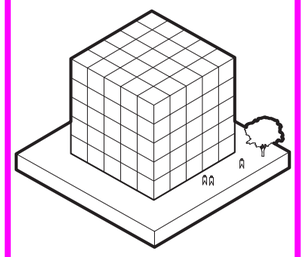
		 0% PSS	 10% PSS	 20% PSS	 30% PSS	 40% PSS	 50% PSS
CAPEX Investment		€10m	€9m	€8m	€7m	€6m	€5m
OPEX Increase (Net Present Value)	**TCU/TCO**						
	1.0 (0% savings)	-	€1.00m	€2m	€3m	€4m	€5m
	.75 (25% savings)	-	€.75m	€1.5m	€2.25m	€3m	€3.75m
	.50 (50% savings)	-	€.50m	€1m	€1.5m	€2m	€2.5m

Financial Simulation (Market-Rate Housing)

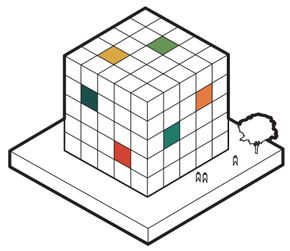
All Scenarios: €10 million building is constructed

Benchmark:

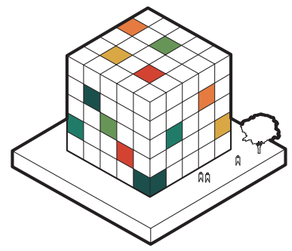
"Traditional Building"



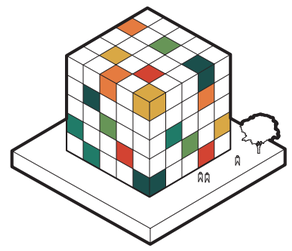
0% PSS



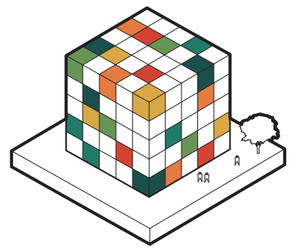
10% PSS



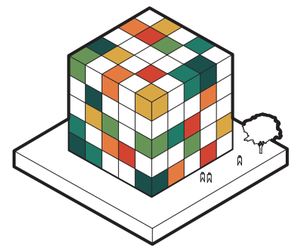
20% PSS



30% PSS



40% PSS



50% PSS

CAPEX Investment		€10m	€9m	€8m	€7m	€6m	€5m
OPEX Increase (Net Present Value)	**TCU/TCO**		15 Scenarios				
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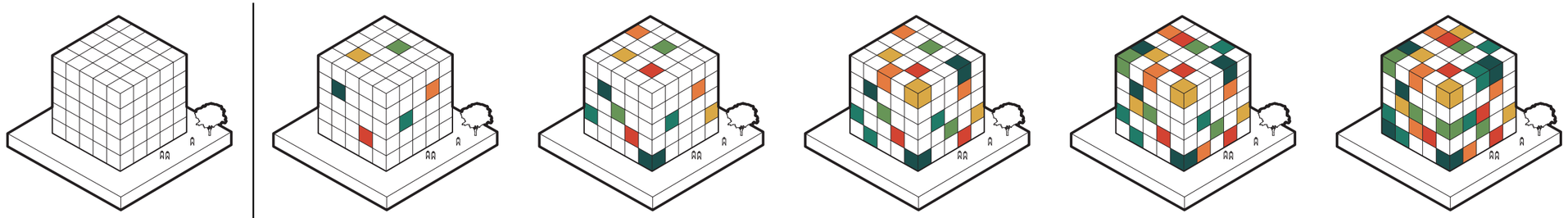

		0% PSS	10% PSS	20% PSS	30% PSS	40% PSS	50% PSS
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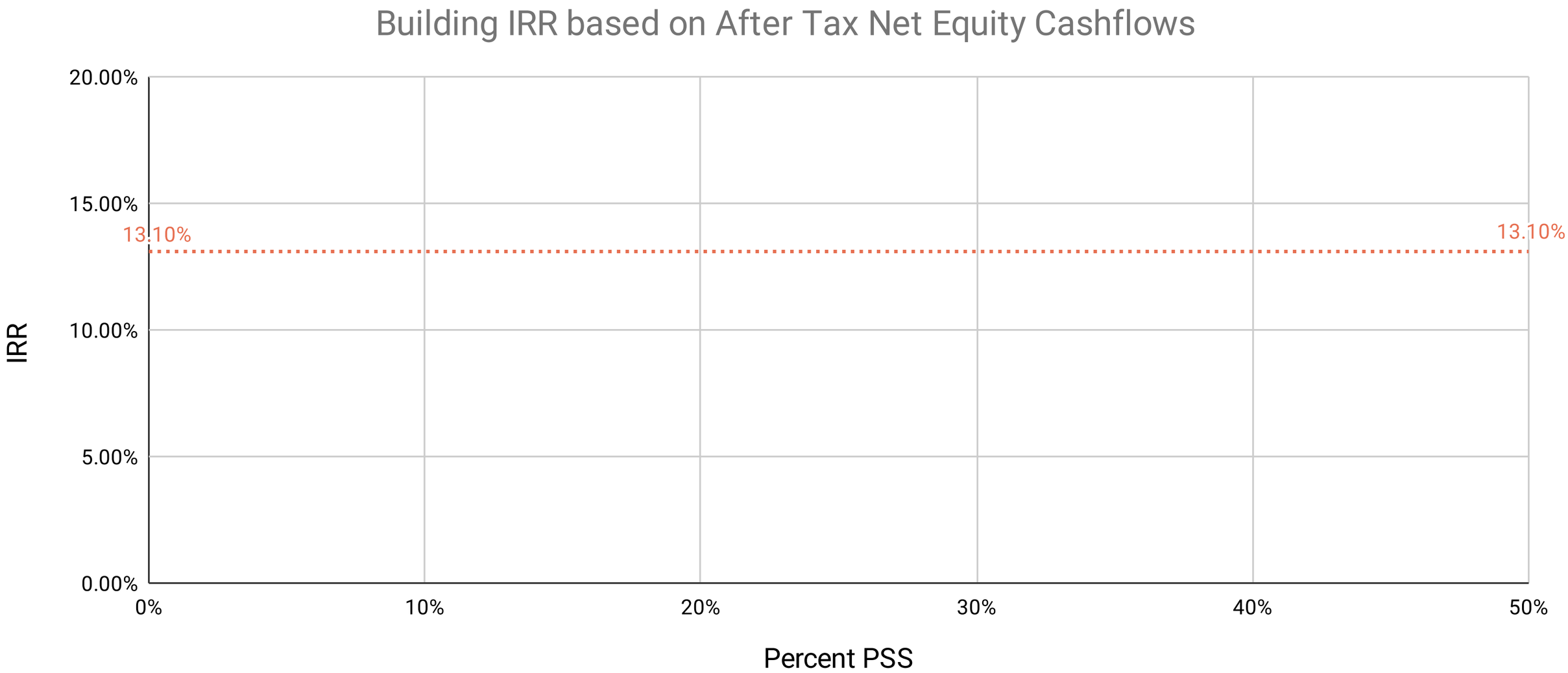
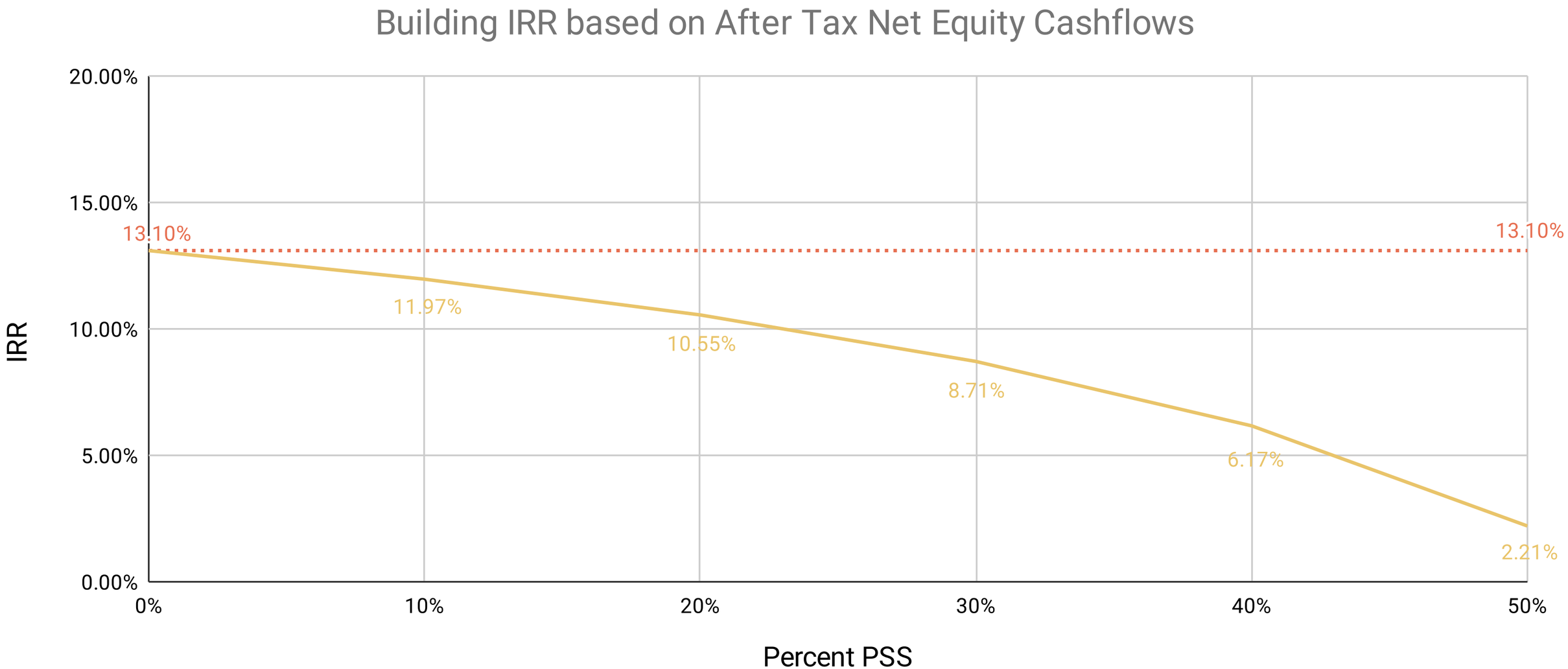


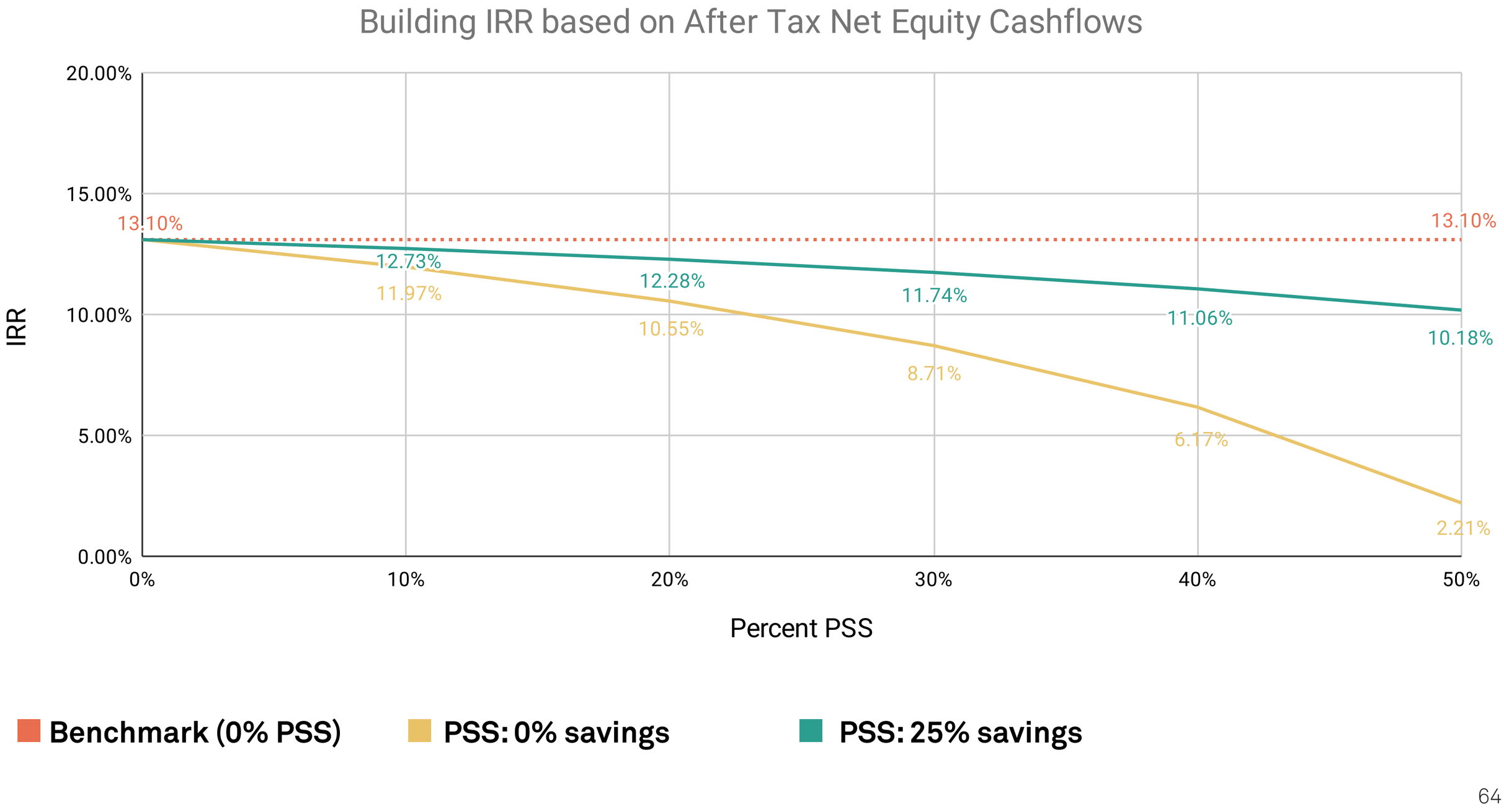
Benchmark (0% PSS)

Financial Simulation (Market-Rate Housing)



Benchmark (0% PSS) **PSS: 0% savings**

Financial Simulation (Market-Rate Housing)



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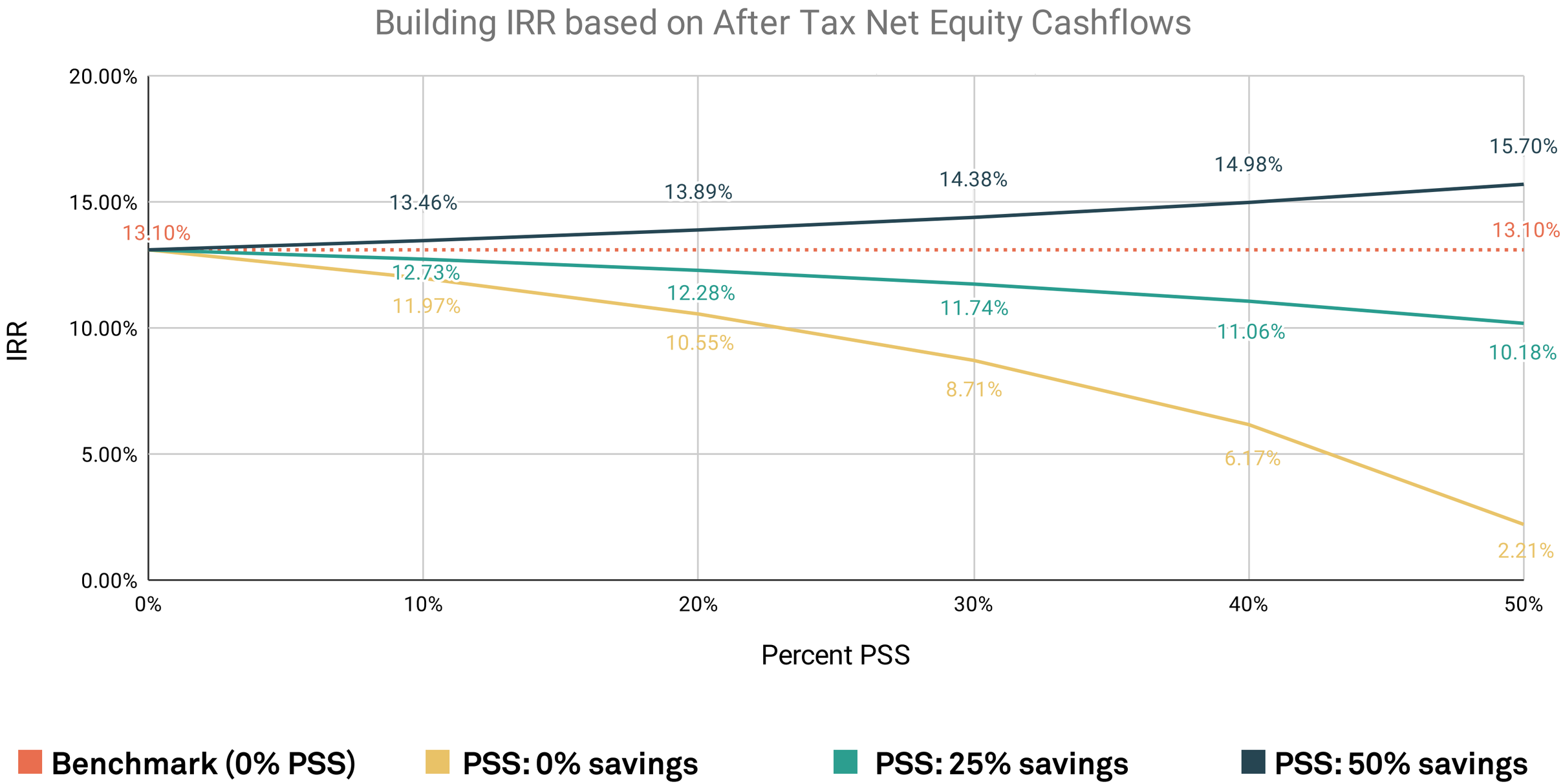

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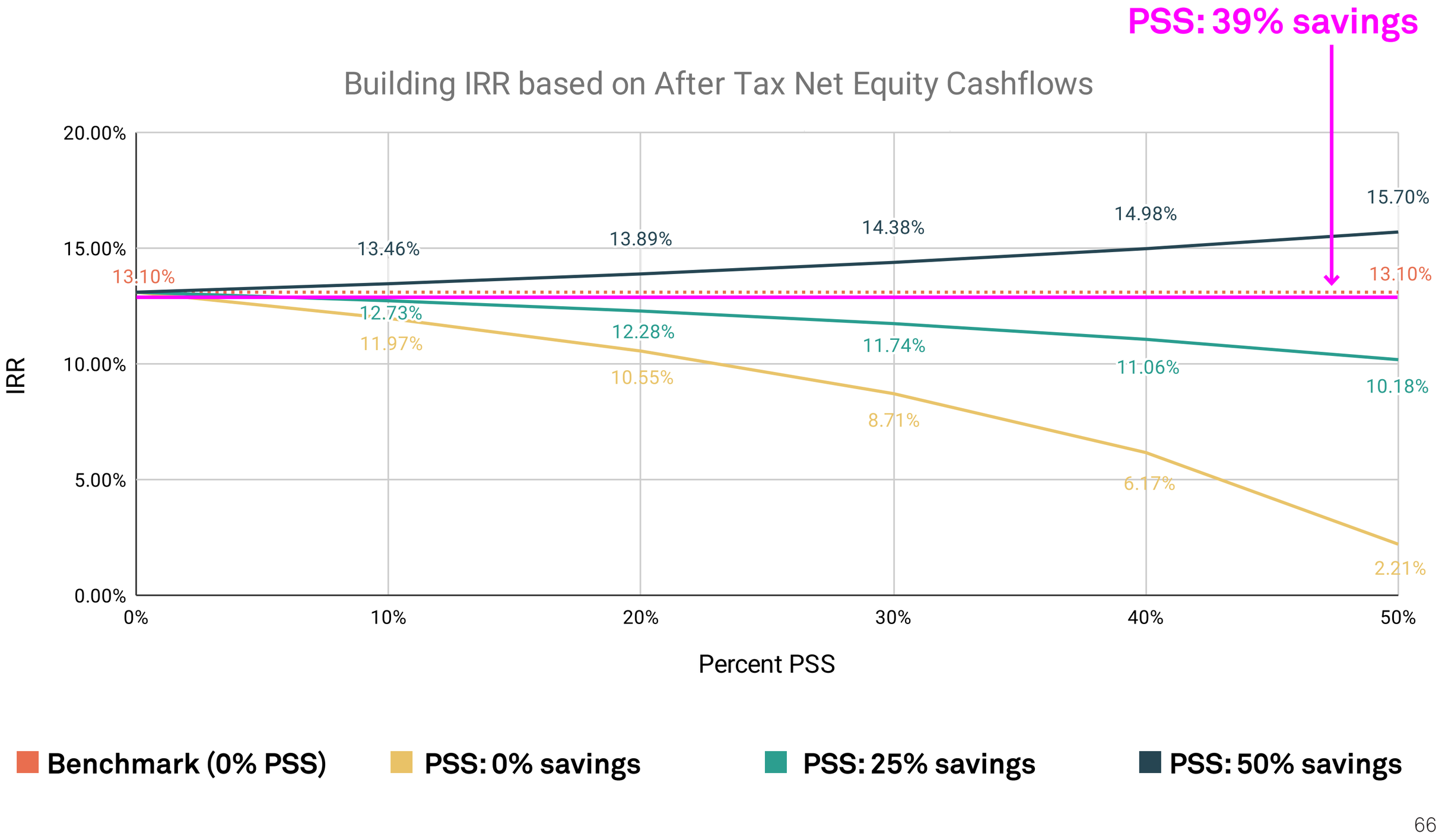

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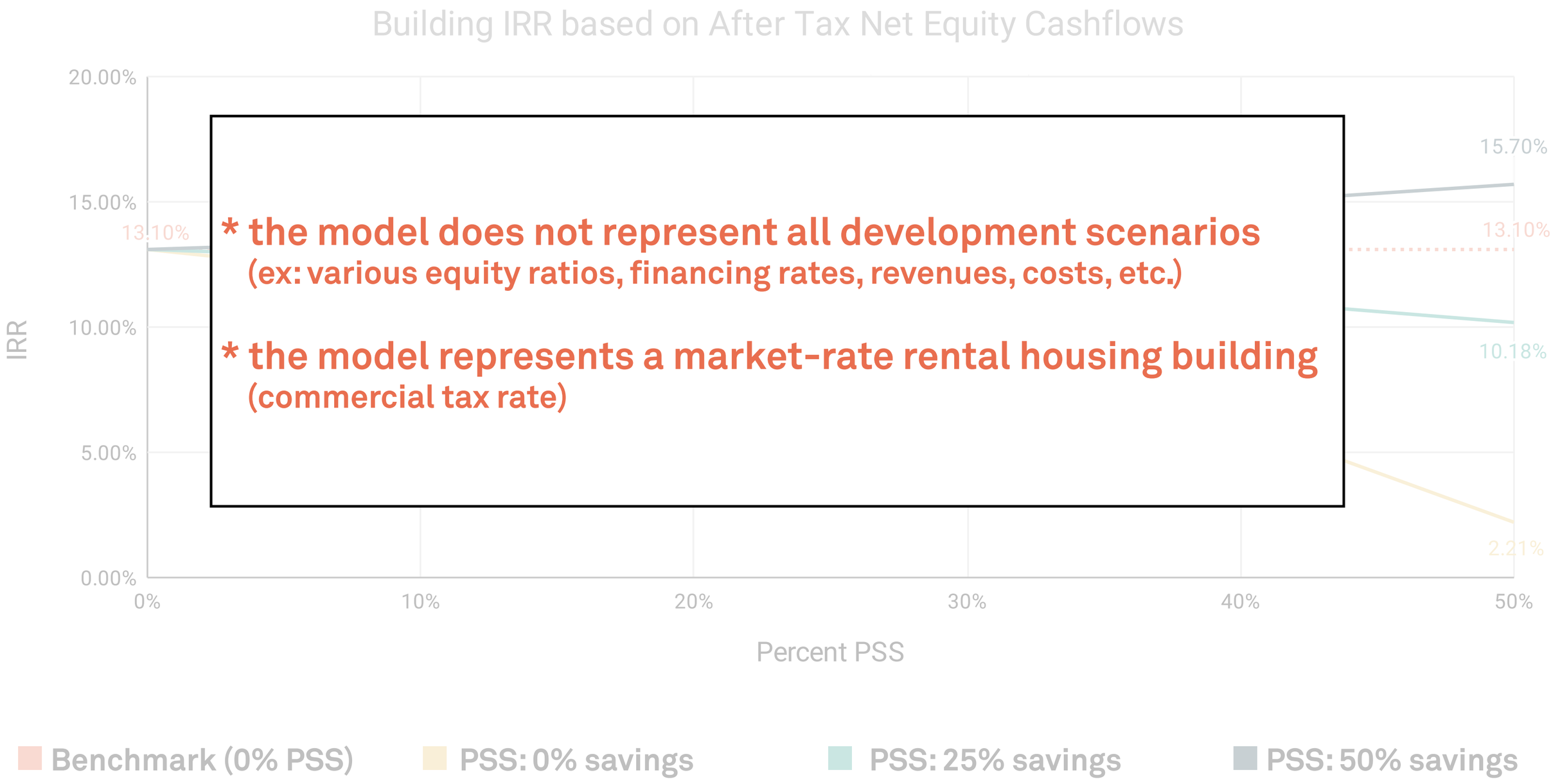
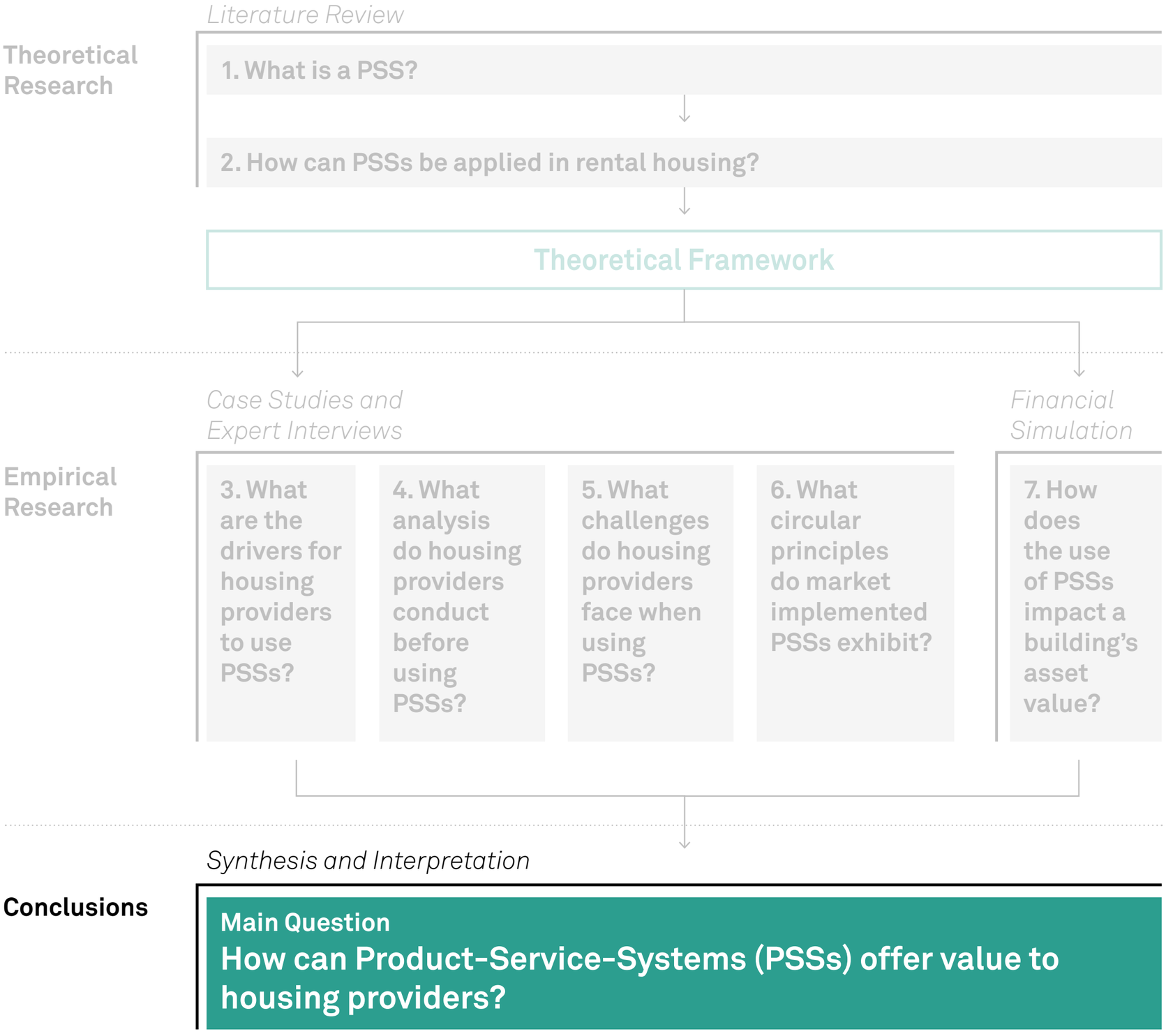


How does the use of PSSs impact a building's asset value?

Still largely unknown how leasing PSSs will impact a building's asset value...

However, there is a significant tax disadvantage when leasing...

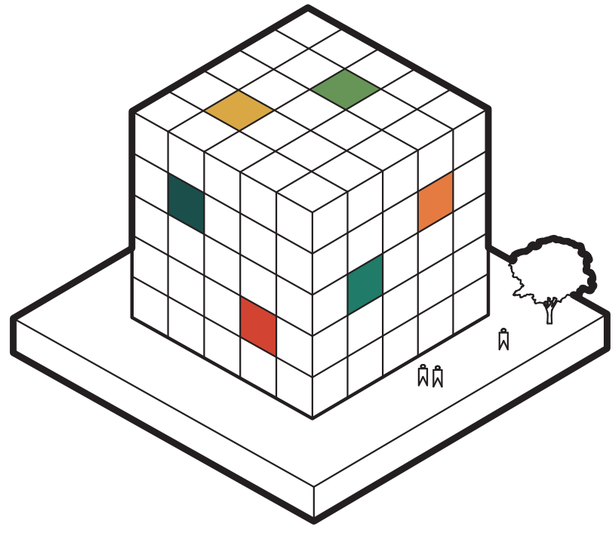
Methodology



Conclusions

How can Product-Service-Systems (PSSs) offer value to Housing Providers (HPs)?

1) Primarily offer Financial and Risk Management Value



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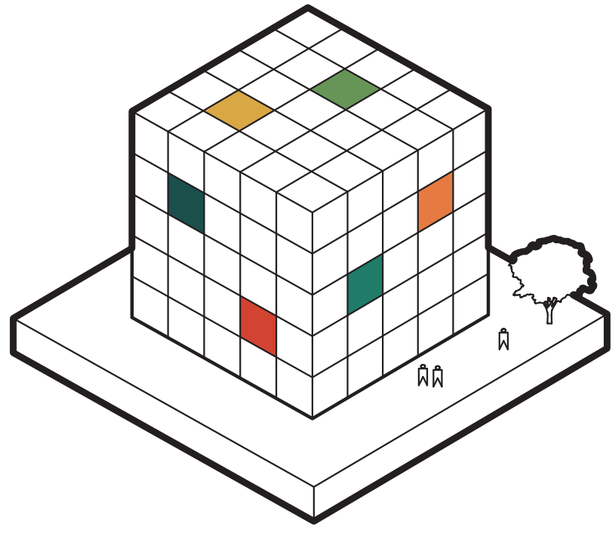

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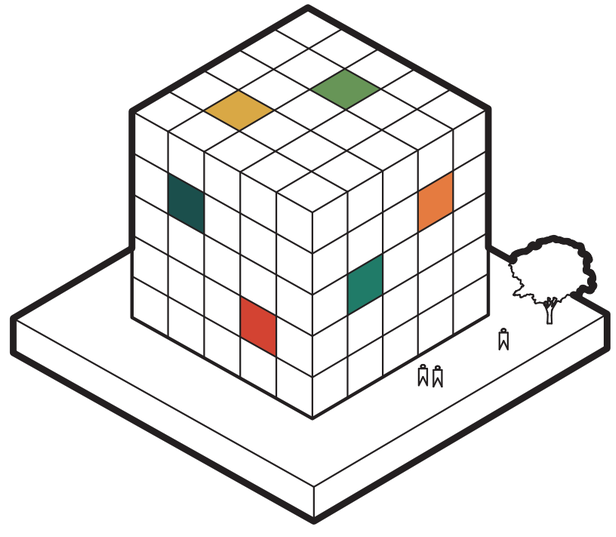
   - Outsourcing risk & responsibilities
   - Accomplishing scope without capital *(leased only)*

Conclusions



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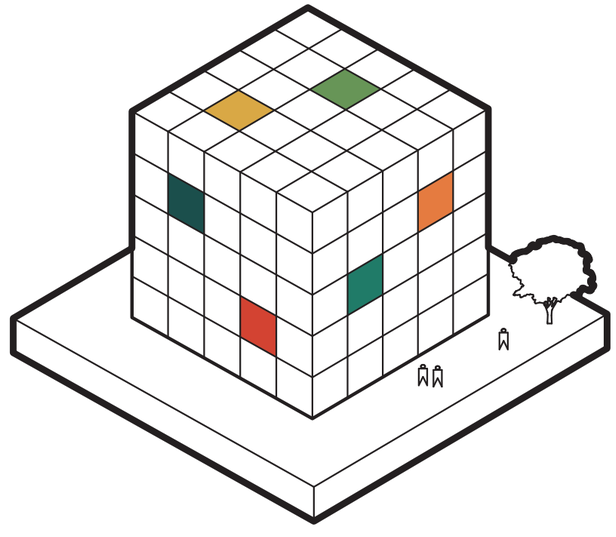

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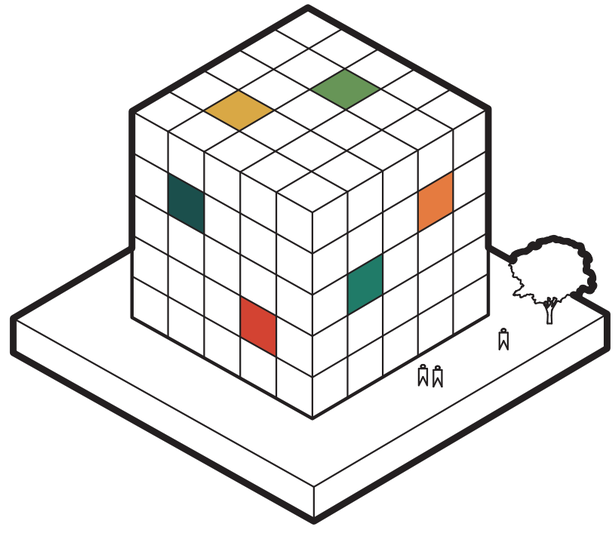

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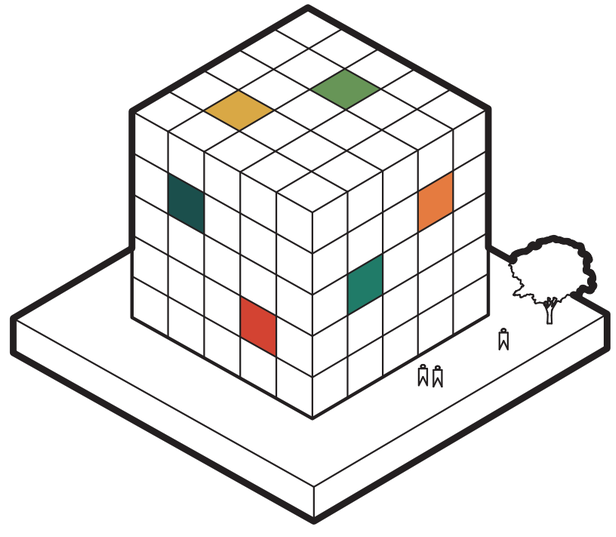

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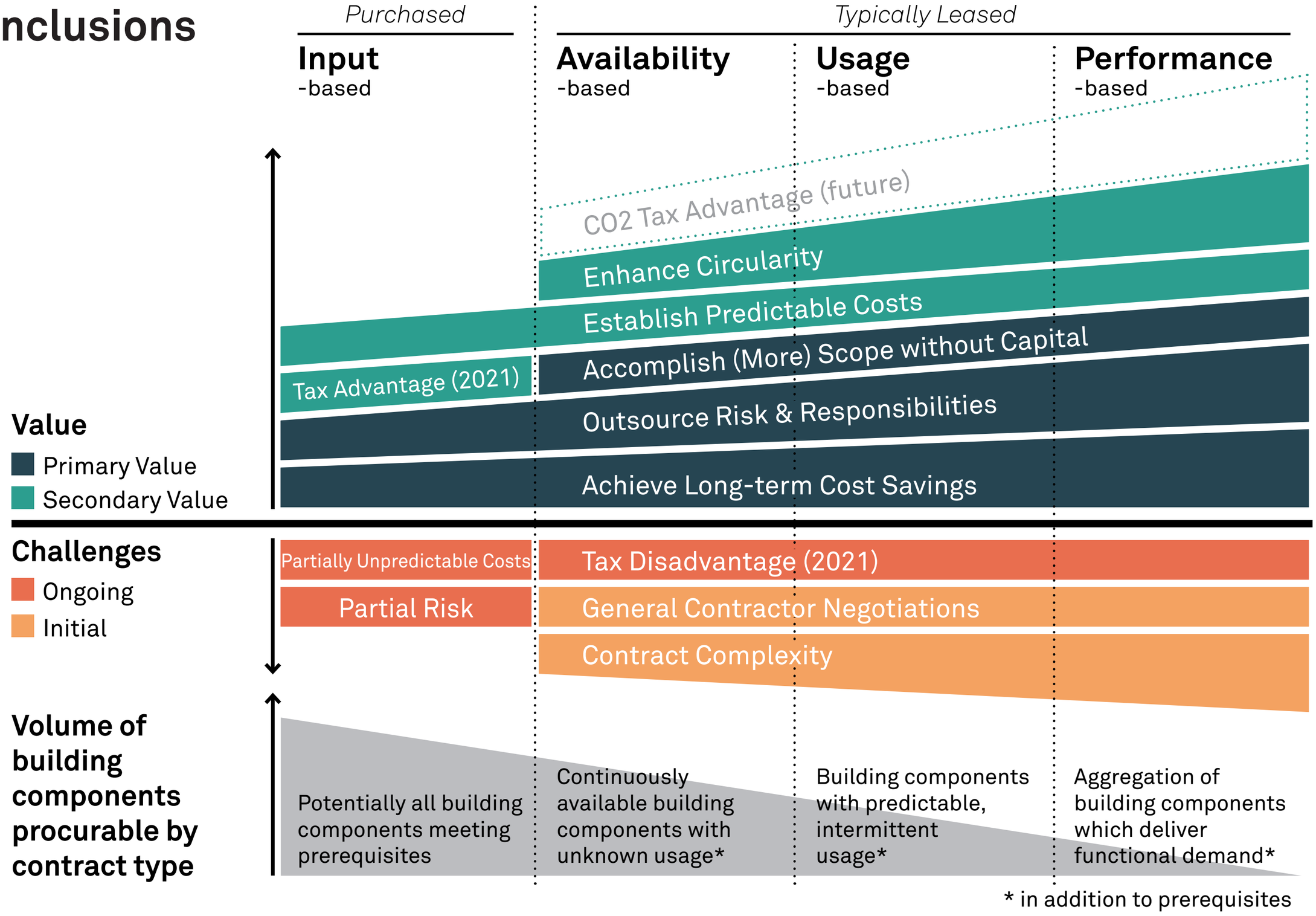
6) Tax disadvantage of leasing is significant (market-rate housing)

Conclusions



Practitioners: to lease, or not to lease?

Case by case basis...

- **Consider if maintenance/operation is part of core-business**

- **Review financial implications:**
  - TCO vs TCU
  - Tax implications

- **Review risk profiles of owning vs leasing**

- **Consider what additional scope can be accomplished**

- **Assess the PSS Provider’s incentives to deliver satisfactory service**
  (PSS type, any penalties for PSS provider, contract duration, % of service payments)

Implications of Research

- **Leasing PSSs can enhance building operations, but likely reduces investment returns** (commercial buildings)

- **Thus, leasing PSSs will be a minority of all building components, but will become more commonplace due to:**
  - Tight construction budgets (energy transition)
  - Advancing technology
  - Implementation of CO2 taxes

- **Leased PSSs contribute in achieving circularity in the built environment, with clear value from both supply + demand perspectives**

- **To achieve total circularity in the built environment, PSS is part of the solution**

Research Output

Housing Providers and Real Estate Owners:

- **Specific PSS examples** *(case studies)*
- **Multiple perspectives on the value of PSSs** *(case studies)*
- **Insights into analysis and potential challenges** *(case studies)*
- **Tax implications of leasing** *(financial model)*

More informed decision making

PSS Providers:

- **Understanding of value they deliver to PSS users**
- **Insights into challenges faced by PSS users**

Improved PSS offerings

Thank you!

Justus & Louise van Effen
Excellence Scholarship

Dr.
Tuuli
Jylhä

Dr.ing.
Gerard
van Bortel

Dr.
Daan
Schraven

Rob
van
Willigen

Theoretical Framework

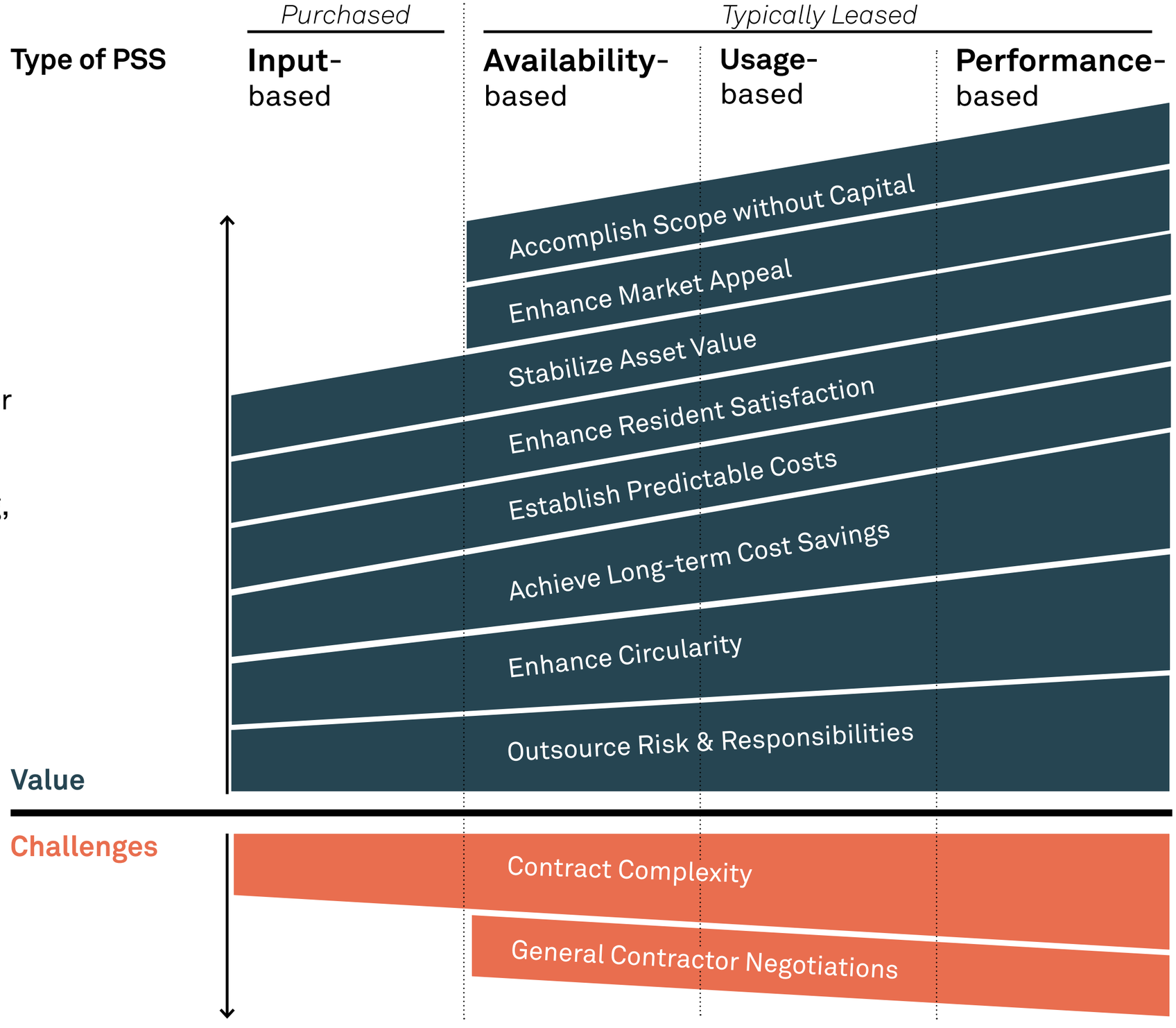
Building component prerequisites

<u>Those that require:</u>

1) intensive maintenance or frequent replacement,

2) inspection or monitoring,

3) replacement before exceeding technical lifespan



Gielingh et al. (2008), den Heijer (2011), van Ostaeyen et al. (2013), Azcarate-Aguerre et al. (2017) Blüher et al. (2020).

17 semi-structured 1-hour interviews, coded & analyzed

	Code	#	Organization	Role	Interviewee Name	Type
Demand + Supply (5)	Case A - HP1	01	Social/ Affordable Housing Provider	Regional Director of Maintenance	-	Video call
	Case A - HP2			Regional Director of Maintenance	-	
	Case A - PSSP	02	Elevator Provider	National Account Manager	-	Video call
	Case B - HP	03	Market Rate Housing Provider	Owner & CEO	-	Video call
	Case B - PSSP	04	Kitchen Provider	Co-founder & CEO	-	Video call
	Case C - HP	05	Market Rate Housing Provider	Technical Developer	-	Video call
	Case C - PSSP	06	Window Provider	Specialist Circular Facades	-	Video call
	Case D - HP	07	Social/ Affordable Housing Provider	Project Leader and Consultant Sustainable Energy	-	Video call
	Case D - PSSP	08	Battery Provider	Client Developer	-	Video call
	Case E - HP	09	Market Rate Housing Provider	Senior Project Developer	-	Video call
	Case E - PSSP	10	Elevator Provider	Head of Sales New Installations	-	Video call
Supply-Only (2)	Case F - PSSP	11	Heat Pump Provider	Managing Partner	-	Video call
	Case G - PSSP	12	PV Panel Provider	Director	-	Video call
Experts (5)	Expert 1	13	ABN AMRO	Commercial Advisor Product-as-a-Service (PaaS)	Rob van Willigen	Video call
	Expert 2	14	TNO	Business Developer, Circular Economy Buildings & Infrastructure	Mark van Ommen	Video call
	Expert 3	15	Turntoo	Co Founder, circular economy expert & innovator, author of Material Matters	Sabine Oberhuber	Video call
	Expert 4	16	Een Veilig Gevoel	Founder and Shareholder	Rick Ruisch	Video call
	Expert 5	17	Volantis	Circular Innovation Consultant	Jeroen Reumkens	Video call

Financial Simulation