Causal Models of Human Behavior from Human Experts

CaDis- Workshop on Causal Discovery 2023

Preliminary results

WHY Project

www.why-h2020.eu

European and Latin American archetypes

Analysis of results, 2023

CLIMBING THE CAUSALITY LADDER TO UNDERSTAND THE ENERGY DEMAND ON THE RESIDENTIAL SECTOR

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 891943

Agenda

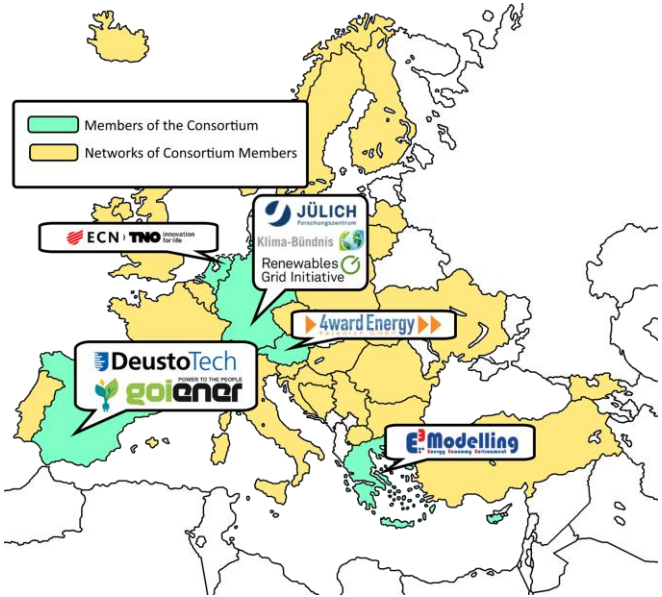
1. Presentation of the WHY project (5')
2. Our Approach
3. Methodology

    3.1 Activities to retrieve expert knowledge

    3.2 Activities to come up with existing archetypes

        3.2.1. Activities carried out to align the determinants per archetype on each of the TTM stages
1. Archetypes from Bilbao
2. Archetypes from LATAM
3. Contributions
4. Future work

1. The WHY Project



¿Who we are?

- Partners covering the entire innovation value chain
  - 1 University,
  - 3 RTOs,
  - 1 SME,
  - 1 Industry and
  - 2 NGOs
- Geographically distributed across Europe and with several advisory board members around the world

Basic Research | Development | Validation | Uptake

DeustoTech

ECN TNO innovation for life

Climate Alliance

4ward Energy Research GmbH

goiener POWER TO THE PEOPLE

JÜLICH Forschungszentrum

E3Modelling Energy Economy Environment

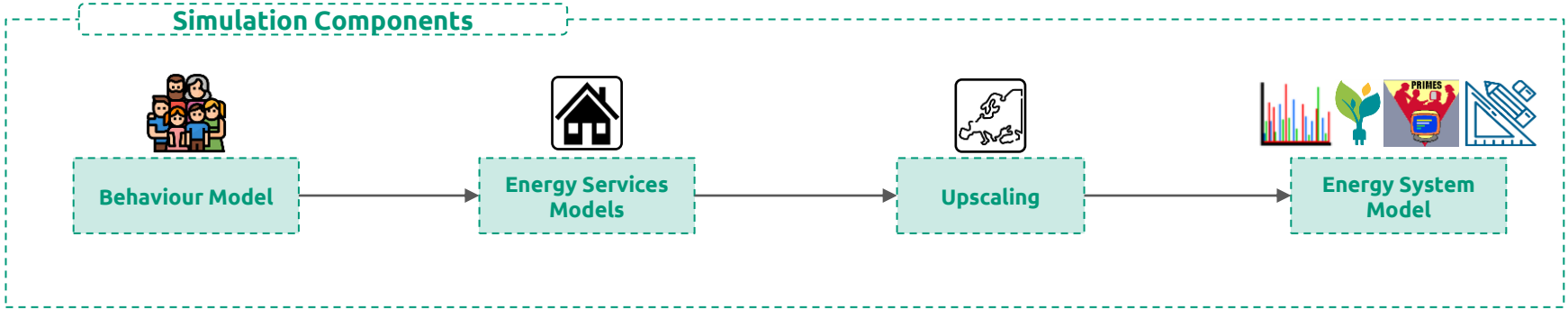
Renewables Grid Initiative

Key objective of WHY

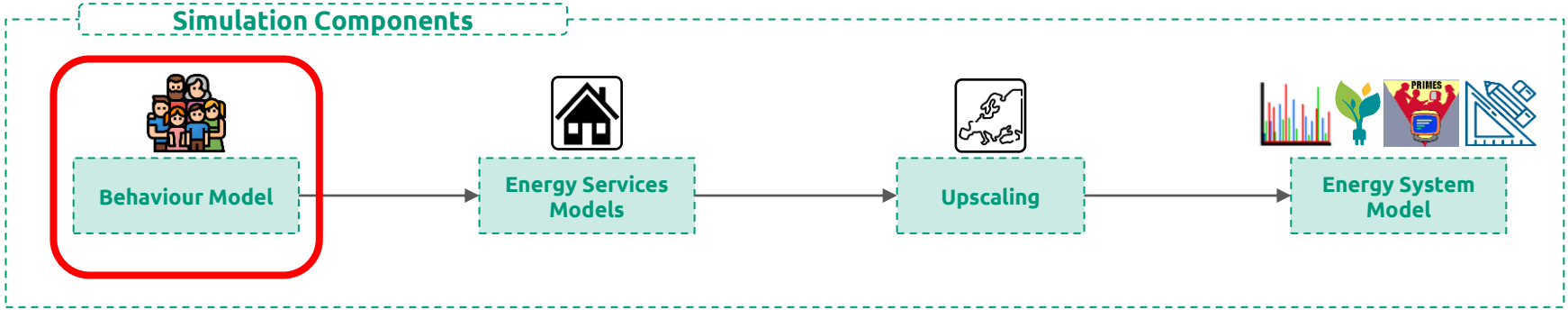
Improve the assessment of electrical energy consumption trends on households by including **causal models** in leading Energy System Models (ESM) focusing on:

- Energy efficiency (EE)
- Distributed Generation (DG)
- Demand Response (DR)
- Electrification of Services (ES)

Concept


Simulation Components
Behaviour Model
Energy Services Models
Upscaling
PRIMES
Energy System Model

Concept


Simulation Components
Behaviour Model
Energy Services Models
Upscaling
PRIMES
Energy System Model

Use Cases

Scenarios	Geo.	Temp.	ESM	Objective
Gniebing Microgrid Operation	City	Hourly / Yearly	Load Profile Generator	• Improve load **forecasting** under normal operation • Create load profiles under black-out operation
Energy Cooperative O&P	Regional	Hourly / Yearly	Own Model	• Improve load forecasting under normal operation • **Test the impact of new policies** / tariff have on the utility
Energy Community	City	Hourly / Yearly	Load Profile Generator	• Create tool to size the different components and to define the business and governance models • **Help designing interventions** that increase the participation on the energy community
2030 & 2050 European energy strategy	European	2030 / 2050	PRIMES	• Create different load profile under different interventions to foster EE, DG, DR and ES • **Assess the impact** of different EE campaigns
Global energy scenario	Worldwide	2100	TIAM-ECN	• Create different load profile under different interventions to foster EE, DG, DR and ES • Project business as usual energy consumption

2. Our Approach

Introduction

- **Paris Agreement,** it guides all nations to substantially reduce global greenhouse gas emissions [1].
- **Households** are estimated to account for around: **72%** of global emissions [2], **27.4%** of final energy consumption or **18.7%** of gross inland energy consumption in the EU [3].

This is why **inhabitants of household's sector** should think how to **behave/change** to help achieve the 1.5° target. However, the social and political environment in which we live also **influences** our lifestyle.

[1] UN, The paris agreement — united nations (2015)
[2] D. Vigran, L. Coscieme, Why do we need 1.5° lifestyles? — 1.5° lifestyles
[3] EC, Energy consumption in households - statistics explained

…introduction

- Mitigating climate change effects, urgent action is required.
- On the supply side, energy system models (ESMs) have provided useful results
- On the demand side, they **lack** the degree of accuracy required for proper characterization of the use of energy in households.

To overcome this challenge, the new **Causal Modelling** will be used to quantitatively analyse **human decision-making,** The WHY project develops a new **causal model** combined with an **innovative profiling approach** to analyze **human decision-making** in energy consumption and human **reactions to changes in energy policy** (e.g., Many European countries are introducing policies to try and curb the impact of rising energy prices on households and businesses)

…introduction

WHY project aims to understand what, when, how much and why energy is consumed at households.

Understanding these questions will help to build a Causal Diagram that allows transitioning from a set of association rules [that can only capture the current status] between the characteristics of the households and their occupants and their energy consumption to a causation model. This way, it would be possible to assess not only the possible outcome of an intervention (e.g., what effect will have the introduction of a tax on excessive energy consumption on the load profile of a residential building?) but also fully understand the future or past status of the system and load profiles (for example, how much energy would households consume if Energy Efficiency labels would have not been implemented?).

Methodology

This work describes the methodology used to retrieve the knowledge of a panel of experts from Europe and Central-South America, and built the causal diagram of the reasons that affect **energy investment in the energy transition**. The causal diagram represents the internal causal relationships (edges) of internal/external variables (nodes) related to an investment decision.

Triangulating evidence

Causal inference is a complex scientific task that relies on triangulating evidence from multiple sources and on the application of a variety of methodological approaches.

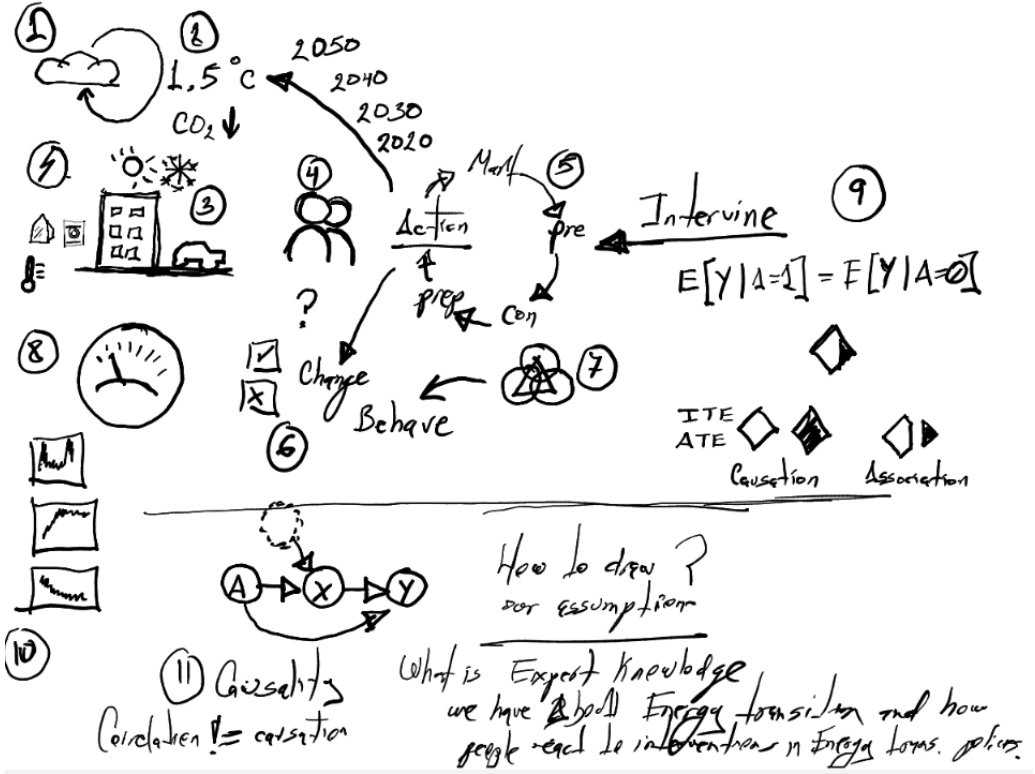
Besides, this work also includes a triangulation approach as a comparative strategy for examining data that strengthens qualitative and multi-method research.

(i) interdisciplinary triangulation,

(ii) methodological triangulation, and

(iii) collaborative triangulation

Brainstorm for shaping our approach



3. Methodology

Methodology for causal Modeling

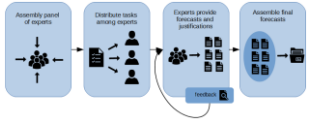
- Phase 0: **Literature review**. The causal model frameworks, Human behaviour theories and Energy transition;
- Phase 1: **Use case description**. For this study four main aspects of the energy transition;
- Phase 2: **Generation of Speculative scenarios** (Minimum, Probable, Plausible, and Ideal). A panel of experts (Panel-A) will define the speculative scenarios on four main aspects of the energy transition;
- Phase 3: **Obtaining determinants**. Another panel of experts (Panel-B) is assembled and is assigned the task of obtaining the determinants for each aspect of the energy transition;
- Phase 4: **Creation of a common glossary.** Coding and agreement of the answers collected, in each energy aspect, by several researchers;
- Phase 5: **Creation of decision-maker archetypes**. Archetypes at the household level;
- Phase 6: **Creation of Causal diagrams**. Building a causal diagram per archetype according to the TTM based on the most impactful determinants to each archetype

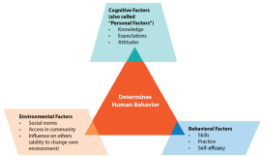
3.1 Activities to retrieve expert knowledge

Building a taxonomy of determinants related to investment decisions

Behavioural theories

- Delphi method
- Social Cognitive Theory as a guide to understand the determinants we expect
- Self determination theory: understanding determinants according to motivation
- The Transtheoretical Model (Stages of Change)





Phase 1. Use case description

Four aspects of the energy transition were established

Building
(Heating and Insulation)

Flexibility
(Distributed Generation, Storage, LFM, Aggregators, etc.)

Everyday Appliances
(Energy efficiency, Sharing Economy, Sufficiency)

Mobility
(EV, Micro Mobility, Public Transport, etc.)

Phase 2. Speculative Scenarios

For each aspect, we created 4 speculative scenarios (plus a baseline):

- **Minimum:** minimum effort required (usually behavioural aspects) to improve the baseline scenario (business as usual) of the particular aspect of application.
- **Probable:** most probable decision making that citizens in whatever European city would take in the following years from the baseline scenario.
- **Plausible:** less probable scenario, yet it would not be too strange to happen in some EU cities or family units in the following years.
- **Ideal:** ideal scenario, yet highly unlikely to happen due to the massive social innovation that entails.

Objectives

For each aspect and speculative escenario, we wanted to know which are:

- The **Intrinsic** and **Extrinsic** determinants that foster citizens' investment decisions.
- The potential **Barriers** that hinder such an investment.
- Whatever **Rebound Effect** that could happen/arise while fostering the scenario.

Panels of experts

For each aspect, we recruited a panel of experts:

- **Interdisciplinar:** with experts on the technical, economic, social and psychological facets of the aspect.
- **Intersectorial**: including experts from the four sectors: academia, enterprises, public authorities and civil society.
- **International:** including experts from different countries and cultural backgrounds.
- **Gender balance:** including as much females as possible.

Description of the panels

	Number	Interdisciplinar	Intersectorial	Internacional	Gender Balance
Building (Heating and Insulation)	7 / 13	All four fields	Academia, Industry & Public Authorities	Austria, Spain, Romania, Croatia and Poland	1 female
Everyday Appliances (Energy efficiency, Sharing Economy, Sufficiency)	13 / 10	All four fields	Academia & Industry	Austria, Norway and Greece	3 females
Flexibility (Distributed Generation, Storage, LFM, Aggregators, etc.)	7 / 12	All four fields	Academia, Industry & Civil Society	Spain, Austria, Germany, Sweden and Bulgaria	4 females
Mobility (EV, Micro Mobility, Public Transport, etc.)	4 / 14	Except psychology	Academia & Industry	Poland, Spain and Estonia	2 females

Mobility: Speculative scenarios

Base Scenario

You live
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reachabl
transport
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Traveling
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populatio
transport
by other

Minimum Scenario

A
ve
cl
A

Probable Scenario

All pub
numbe
cities a
transpo
MyTaxi
scooter
their n
mostly
reduce

Plausible Scenario

Electric robotax
micromobility, e
density zones, t
continue to have
and there is mor
used for mediun
means inside th
mobility). Long-d
and the amount

Ideal Scenario

The cities are re-designed (for example with 15 mins cities or superblocks) in a way that all services are at foot distance so the number of vehicles is drastically reduced and a combination of public or private personal mobility, robotaxis and electric public transport supply the rest of travel needs (inter and intra city). For these reasons, traffic jams are something from the past. Long distance transport is only made using high speed trains and the amount of travel by plane is drastically reduced to intercontinental travel.

Answers (sticky notes provided)

	Minimum	Probable	Plausible	Ideal	
Flexibility	84	70	72	65	**291**
Appliances	107	101	88	92	**388**
Buildings	58	97	67	70	**292**
Mobility	79	74	63	46	**262**
	328	**342**	**270**	**273**	**1233**

Phase 3. Coding and Themes

With all the answers received (N=1233)

- We coded each answer.
- We found relationships between the codes, so some themes emerged (e.g., financial).
- We used existing theory to underpin the majority of the themes (self determination theory and the main socio-psychological needs).
- We created a taxonomy with all the relations and definitions of the determinants (N=32) and themes (N=9).

Seguridad (Security)

Sentirse seguro y en control de su vida en lugar de sentirse inseguro y amenazado por sus circunstancias.

Durante el evento me sentí...

... que mi vida fuera estructurada y predecible.

...contento de tener un conjunto de rutinas y hábitos cómodos.

... a salvo de amenazas e incertidumbres.

Estimulación (Stimulation)

Relación/Conexión (Relatedness)

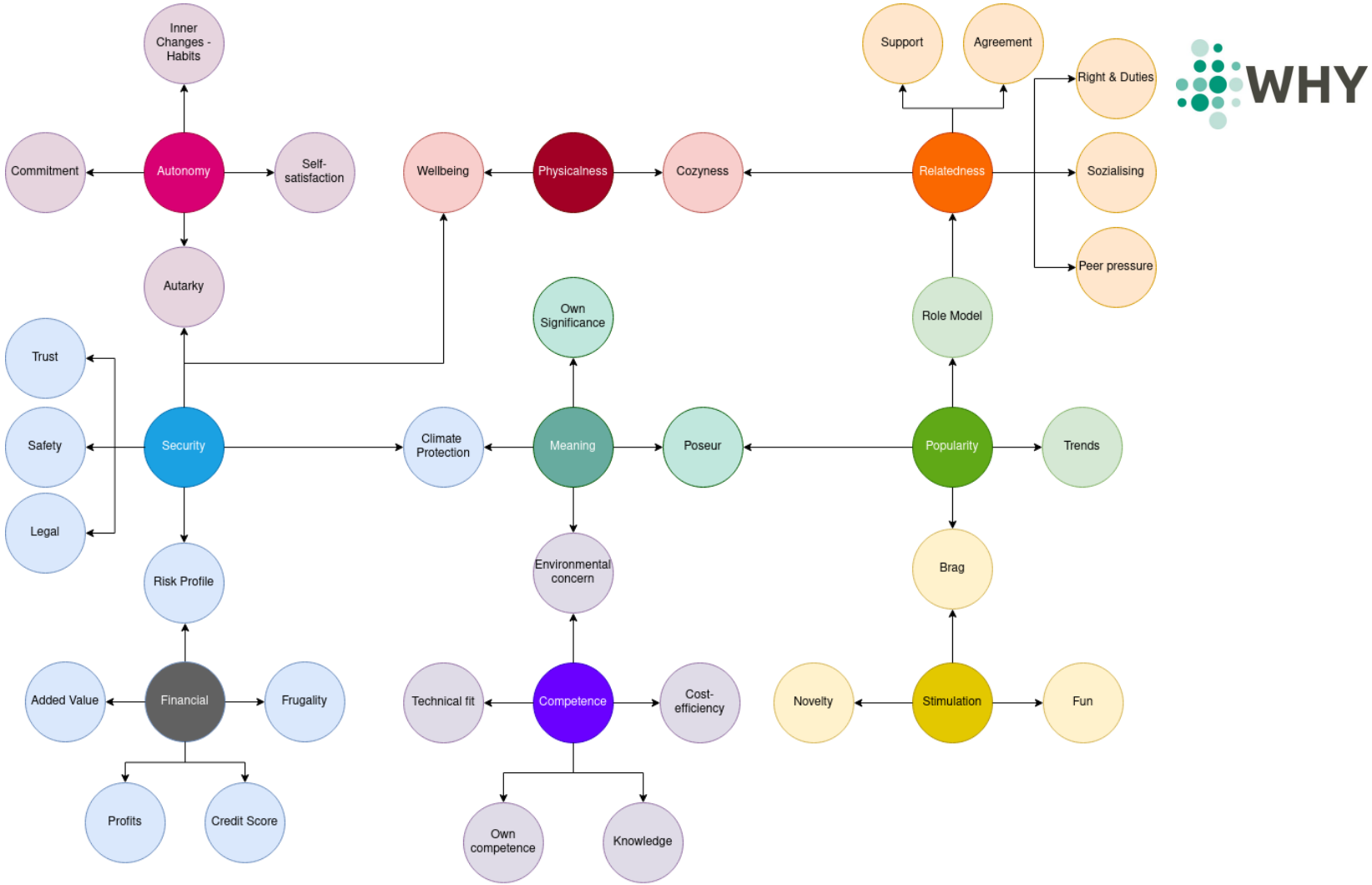
Popularidad (Popularity)

Competencia (Competence)

Apto fisicamente (Physicalness)

Sentido/Significado (Meaning)

Phase 4: Creation of a common glossary

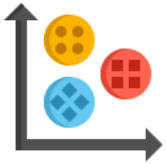


Occurrence of the Themes by Aspect

	Flexibility	Appliances	Building	Mobility	TOTAL
Financial	18%	13%	32%	16%	19.8%
Security	10%	11%	10%	20%	13%
Competence	26%	29%	15%	22%	23%
Autonomy	7%	6%	4%	5%	6%
Physicalness	0%	1%	5%	4%	3%
Relatedness	24%	21%	18%	15%	19.5%
Stimulation	3%	4%	3%	3%	3%
Popularity	7%	10%	8%	7%	8%
Meaning	5%	6%	6%	7%	6%

Phase 5. Creation of decision-maker archetypes - Methodology

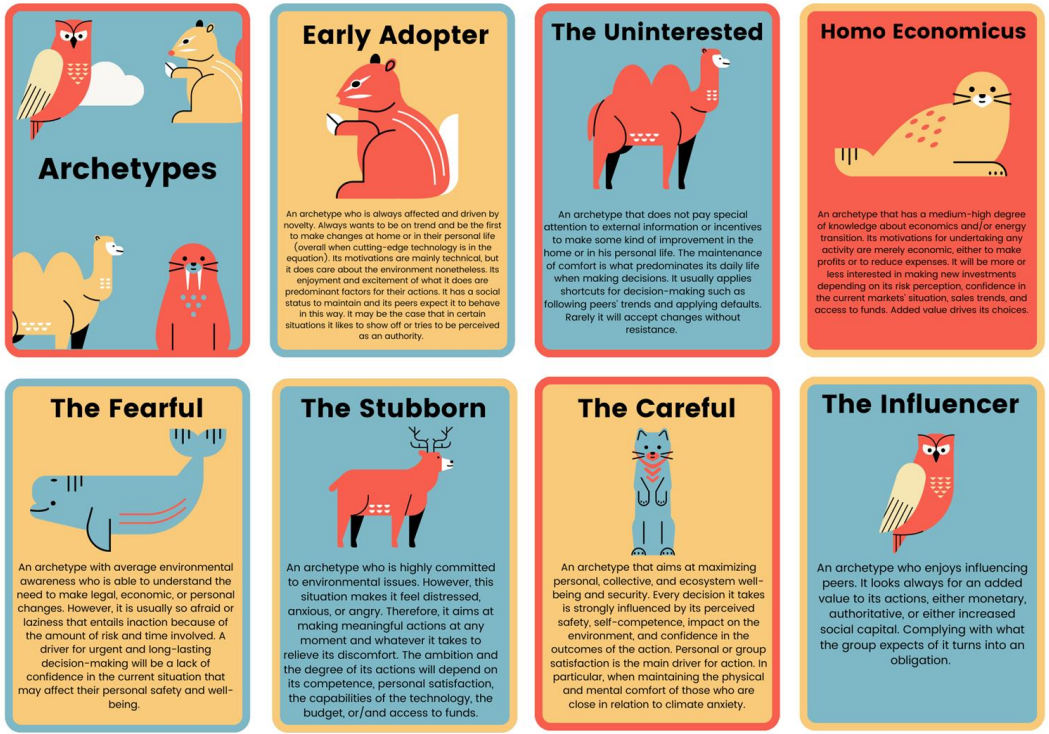
- Survey about the relation of the 32 determinants with investment decisions.
  - 1700 answers (1000 EU + 700 LATAM)
- Cluster the answers using k-means.
  - Hyperparameters: 8 clusters and 15 determinants per cluster
- Monte Carlo simulation to get the cluster's distribution.
  - 200 000 repetitions with 500 samples per repetition
  - "Two clusters are equal if they share 75% of the determinants"



Results

Clusters	Monte Carlo simulation Frequency of each Cluster		
	JOINT	EU	LATAM
NA	6.8	6.3	6.0
Early Adopter	14.1	22.9	24.2
Uninterested	6.1	5.2	5.0
Homo Economicus	9.6	7.9	8.9
Fearful	25.6	15.3	13.2
Stubborn	4.0	13.1	21.6
Influencer	16.6	3.5	3.2
Careful	15.1	24.2	15.8
Activist	2.2	2.0	2.7

Archetypes


Archetypes
Early Adopter
An archetype who is always affected and driven by novelty. Always wants to be on trend and be the first to make changes at home or in their personal life (overall when cutting-edge technology is in the equation). Its motivations are mainly technical, but it does care about the environment nonetheless. Its enjoyment and excitement of what it does are predominant factors for their actions. It has a social status to maintain and its peers expect it to behave in this way. It may be the case that in certain situations it likes to show off or tries to be perceived as an authority.
The Uninterested
An archetype that does not pay special attention to external information or incentives to make some kind of improvement in the home or in his personal life. The maintenance of comfort is what predominates its daily life when making decisions. It usually applies shortcuts for decision-making such as following peers' trends and applying defaults. Rarely it will accept changes without resistance.
Homo Economicus
An archetype that has a medium-high degree of knowledge about economics and/or energy transition. Its motivations for undertaking any activity are merely economic, either to make profits or to reduce expenses. It will be more or less interested in making new investments depending on its risk perception, confidence in the current markets' situation, sales trends, and access to funds. Added value drives its choices.
The Fearful
An archetype with average environmental awareness who is able to understand the need to make legal, economic, or personal changes. However, it is usually so afraid or laziness that entails inaction because of the amount of risk and time involved. A driver for urgent and long-lasting decision-making will be a lack of confidence in the current situation that may affect their personal safety and well-being.
The Stubborn
An archetype who is highly committed to environmental issues. However, this situation makes it feel distressed, anxious, or angry. Therefore, it aims at making meaningful actions at any moment and whatever it takes to relieve its discomfort. The ambition and the degree of its actions will depend on its competence, personal satisfaction, the capabilities of the technology, the budget, or/and access to funds.
The Careful
An archetype that aims at maximizing personal, collective, and ecosystem well-being and security. Every decision it takes is strongly influenced by its perceived safety, self-competence, impact on the environment, and confidence in the outcomes of the action. Personal or group satisfaction is the main driver for action. In particular, when maintaining the physical and mental comfort of those who are close in relation to climate anxiety.
The Influencer
An archetype who enjoys influencing peers. It looks always for an added value to its actions, either monetary, authoritative, or either increased social capital. Complying with what the group expects of it turns into an obligation.

3.2 Activities to come up with existing archetypes

Methodology in Latam

The methodology applied in the European generated the following outcomes:

- Out from the speculative scenarios of energy transition,
- five for flexibility and five for mobility,
- a 32-factor taxonomy and its glossary, and eight archetypes.

Shaping the Archetypes in Latin America consisted of the following steps:

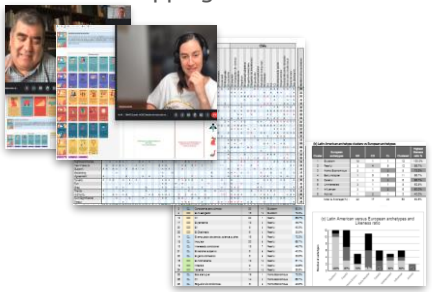
- Step 1. Coordination with the host research team. Workplan of 9 main tasks
  - Mexico (INAOE)
  - Colombia (UniCafam)
  - Chile (UCSC)
- Step 2. Recruitment of experts
  - 28 experts, 13 women among them

Methodology in Latam

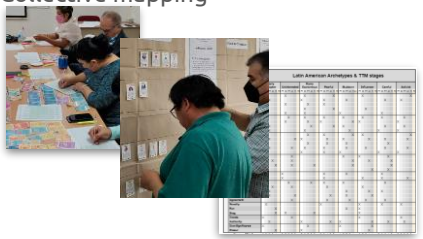
...shaping the Archetypes in Latin America consisted of the following steps:

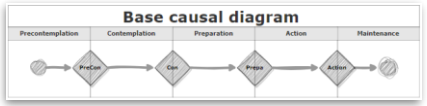
- Step 3. Individual mapping
  - (a) Activity-1 for experts: Contributions on archetypes
    - (i) 59 archetypes contributed by the experts
  - (b) Coding determinants into archetypes
  - (c) Clustering of archetypes
    - (i) Eight clusters
- Step 4. Collective mapping.
  - (a) Activity-2 for experts - Sorting determinants into the TTM Stages
    - (ii) Eight final archetypes
- Step 6. Building causal Diagrams

Individual mapping



Collective mapping



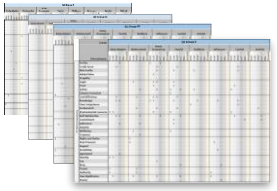


Methodology for Survey

- **Cross-sectional survey**. Collecting data about a population of interest at one point in time and find a set of objective archetypes that characterise as much as possible the European population (and then, also the Latin-American one)
  - **32 questions in 4 sections**: Background, Scenarios, Determinants and Further information
  - Participation:
    - Europe: Over 1000 responses
    - Latin American: Over 700 responses
- **Longitudinal survey**. Trying to interview the same people periodically in order to assess the changes in the population over time to capture as many changes of status in the TTM for each archetype and scenario.
  - **25 questions**, mainly socio-economics that could be answered just one time.
  - Future work

4. European archetypes

European Archetypes & Consensus on the classification of the determinants in the TMD Stages



- 4 Groups
- 8 Archetypes
- 30 individual contributions
- 28 collective contributions

	EU			
Gropus	**F**	**A**	**FF**	M
Early Adopter	H	F	F	
Uninterested	H	F	F	
Homo Economicus	H	F	F	
Fearful	H	F	F	
Stubborn	F	F	F	H
Influencer	F	F	F	H
Careful	F	H	H	F
Activist	F	H	H	F

H	Hybrid session with experts
P	Presential session with experts
F	Follow up session with experts

(h) Europe - Archetypes & TTM stages
Synthesis from groups: F, A, FF and M

	Number of panels	3					3					3					3					4					4					5				
	Archetype	Early Adopter					Uninterested					Homo Economicus					Fearful					Stubborn					Influencer					Careful					Activist				
	Determinants	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE
32-Factor taxonomy	Profits			1										3			1												1													
	Credit Score		1												1						3						1					1	1		1								
	Risk Profile														1					1	2					2					2	1	1										
	Added Value													2													1								1								
	Frugality													1																													
	Legal							1	2					1	1						2												1					2						
	Trust													1	2						3											1	1		1	1	1	3					
	Safety										1				3					3			1			1						3	1								1		
	Climate Protection														1					1						1	1					2	1					1					
	Cost-Efficiency			1						1				1	1	1				1		1			1			1		1			1	1	1	1			1				
	Knowledge			3	1									2	1	1					1	2						1	2				2	2				2					
	Own Competence																									2							1	3							1		
	Technical Fit							1		1						3						3					2						1	1					4			
	Environmental Concerns	2	1											1						1						1						3						3					
	Self-Satisfaction		1	1	2						1						2						1					2	1				1		1				3	1		
	Commitment																			1														1		2			1		1	2		
	Adherence			3						1										1												1		1	1				1	2		
	Autarky																															1		1								
	Wellbeing								2											1	1	1				1	1					2	1		1	1		1					
	Cozyness							2			1																																
	Rights and Duties							1																																1			
	Peer-Pressure		1					2																			4											1	1			
	Support																											1										1				
	Socialising																										3	1											1	1			
	Agreement			1																							2							1								
	Novelty	2	2																							1																	
	Fun														1												1												1				
	Brag			1																		1						4											1	1			
	Trends	3							1															1		1											2						
	Authority	1							1	1																2											1						
	Own Significance		1						1						1							1				1											2						
	Poseur																											1	2														

Final archetypes & Consensus on TTM stage

(n) European Archetypes & TTM stages
Consensus on TTM stages

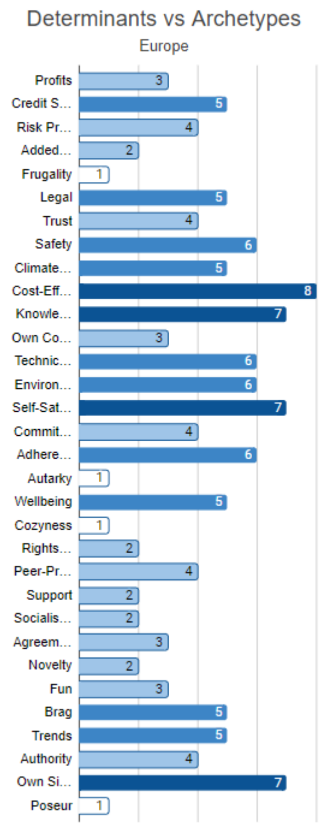
32-Factor teaxonomy

Archetypes	Early Adopter						Uninterested						Homo œconomicus						Fearful					
TTM Stages	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE
Profits				X									X											
Credit Score			X												X						X			
Risk Profile															X					X				
Added Value														X										
Frugality														X										
Legal								X						X						X				
Trust															X					X				
Safety										X					X				X					
Climate Protection															X				X					
Cost-Efficiency			X						X					X							X			
Knowledge			X										X								X			
Own Competence																								
Technical Fit									X						X						X			
Environmental Concerns	X													X					X					
Self-Satisfaction					X					X						X						X		
Commitment																				X				
Adherence				X						X										X				
Autarky																								
Wellbeing								X												X				
Cozyness							X																	
Rights and Duties							X																	
Peer-Pressure		X					X																	
Support																								
Socialising																								
Agreement				X																				
Novelty	X																							
Fun															X									
Brag				X																		X		
Trends	X								X															
Authority	X									X														
Own Significance		X						X							X							X		
Poseur																								

Archetypes	Stubborn						Influencer						Careful						Activist					
TTM Stages	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE	PREC	CON	PREP	ACT	MAI	RELAPSE
Profits											X													
Credit Score									X					X										
Risk Profile		X											X											
Added Value								X																
Frugality																								
Legal															X					X				
Trust																X				X				
Safety		X											X										X	
Climate Protection	X												X							X				
Cost-Efficiency			X					X							X						X			
Knowledge			X						X					X						X				
Own Competence	X														X							X		
Technical Fit			X												X						X			
Environmental Concerns		X											X						X					
Self-Satisfaction				X												X						X		
Commitment					X												X						X	
Adherence					X											X							X	
Autarky														X										
Wellbeing			X										X						X					
Cozyness																								
Rights and Duties																					X			
Peer-Pressure								X													X			
Support											X									X				
Socialising									X												X			
Agreement									X							X								
Novelty							X																	
Fun									X													X		
Brag					X					X													X	
Trends					X		X												X					
Authority							X												X					
Own Significance	X						X												X					
Poseur										X														

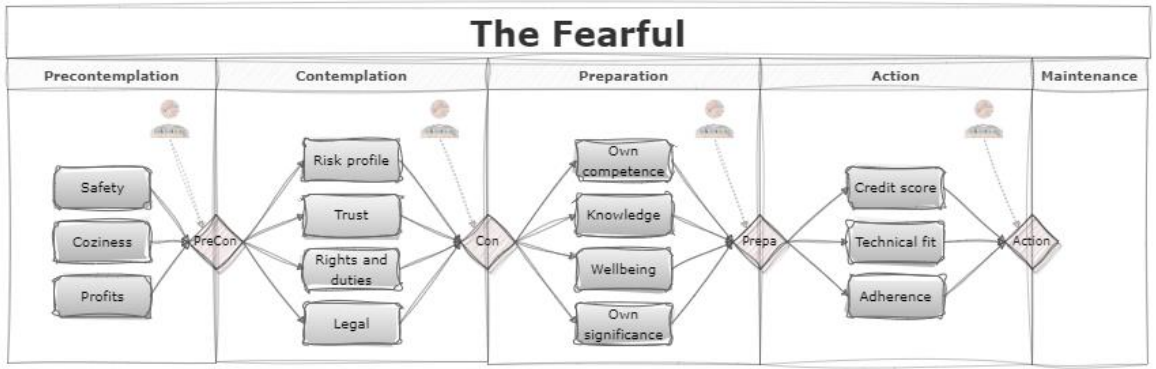
32-Factor teaxonomy

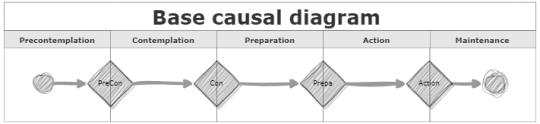
	ARCHETYPES								
	Early Adopter	Uninterested	Homo œconomicus	Fearful	Stubborn	Influencer	Careful	Activist	Total
Profits	1		1			1			3
Credit Score	1		1	1		1	1		5
Risk Profile			1	1	1		1		4
Added Value			1			1			2
Frugality			1						1
Legal		1	1	1			1	1	5
Trust			1	1			1	1	4
Safety		1	1	1	1		1	1	6
Climate Protection			1	1	1		1	1	5
Cost-Efficiency	1	1	1	1	1	1	1	1	8
Knowledge	1		1	1	1	1	1	1	7
Own Competence					1		1	1	3
Technical Fit		1	1	1	1		1	1	6
Environmental Concerns	1		1	1	1		1	1	6
Self-Satisfaction	1	1	1	1	1		1	1	7
Commitment				1	1		1	1	4
Adherence	1	1		1	1		1	1	6
Autarky							1		1
Wellbeing		1		1	1		1	1	5
Cozyness		1							1
Rights and Duties		1						1	2
Peer-Pressure	1	1				1		1	4
Support						1		1	2
Socialising						1		1	2
Agreement	1					1	1		3
Novelty	1					1			2
Fun			1			1		1	3
Brag	1			1	1	1		1	5
Trends	1	1			1	1		1	5
Authority	1	1				1		1	4
Own Significance	1	1	1	1	1	1		1	7
Poseur						1			1



	TTM-Stages					
	PREC	CON	PREP	ACT	MAI	RELAPSE
Profits	1			1	1	
Credit Score		1	4			
Risk Profile	1	2	1			
Added Value		2				
Frugality		1				
Legal		4	1			
Trust		2	1	1		
Safety	2	1	1	1	1	
Climate Protection	3	1	1			
Cost-Efficiency		2	6			
Knowledge	1	2	4			
Own Competence	1		1	1		
Technical Fit			6			
Environmental Concerns	4	2				
Self-Satisfaction				6	1	
Commitment		1			3	
Adherence		1		3	2	
Autarky		1				
Wellbeing	2	2	1			
Cozyness	1					
Rights and Duties	1		1			
Peer-Pressure	1	2	1			
Support		1			1	
Socialising			2			
Agreement			1	2		
Novelty	2					
Fun			2	1		
Brag				3	2	
Trends	3		1		1	
Authority	3			1		
Own Significance	3	2	1	1		
Poseur				1		

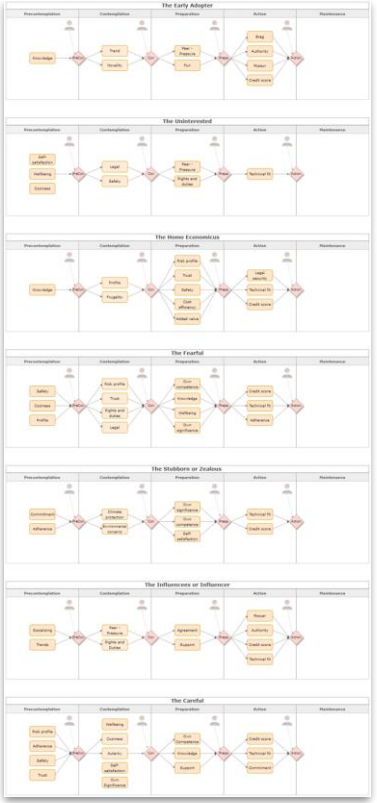
Causal diagrams





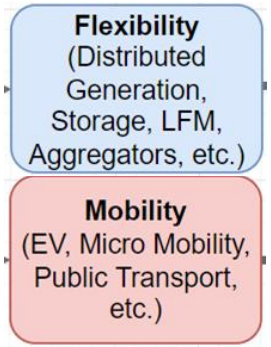
Latent variables

The decision-making process involves factors directly related to individuals, such as gender, age, occupation, income, nationality, ethnicity, education, family situation, hobbies, professional qualifications, etc.



5. Latin American archetypes

Description of the panels



Number	Interdisciplinar	Intersectorial	Internacional	Gender Balance
9 / 16	All four fields	Academia, Industry & Civil Society	México	8 females
10 / 91	Except psychology	Academia & Industry	Colombia	2 females
9 / 13	All four fields	Academia, Industry, Private sector	Chile & Argentina	3 females

From Individuals contributions to Clusterization in the EU archetypes

Latin American vs European archetypes & Likeness ratio

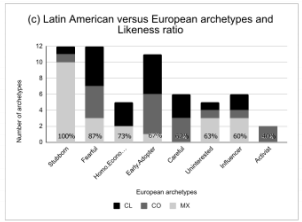
(a) Clustering

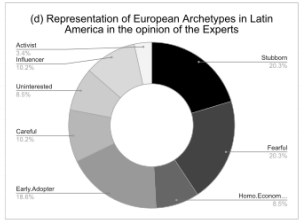
México-INAOE, Colombia-UniCafam, Chile-UCSC

ID	Country	Final Latin American Archetypes	Num of Determinants	Num	European Archetypes	Likeness factor %
1	MX	Ecologista.informado	24	1	Stubborn	100.0%
2	MX	Ambientalista.por.Moda	19	2	Stubborn	88.9%
5	MX	Emprendedor	12	3	Stubborn	66.7%
6	MX	Ideal	15	4	Stubborn	66.7%
7	MX	Obstinado	19	5	Stubborn	66.7%
8	MX	Ingenioso	14	6	Stubborn	55.6%
9	MX	El.Cuidadoso	13	7	Stubborn	55.6%
10	MX	Diligente	12	8	Stubborn	44.4%
11	MX	Derrochador	7	9	Stubborn	33.3%
12	MX	Ahorrador	6	10	Stubborn	33.3%
3	CL	Consciente.pero.cómodo	20	11	Stubborn	80.0%
4	CO	El.investigador	18	12	Stubborn	73.3%
13	CO	C1	24	1	Fearful	86.7%
17	CO	El.pensante	12	2	Fearful	46.7%
20	CO	E1	9	3	Fearful	40.0%
22	CO	El.Obstinado	6	4	Fearful	33.3%
14	CL	El.empujador.de.ciencia..science.pusher.	16	5	Fearful	73.3%
15	CL	Impulsor	20	6	Fearful	66.7%
18	CL	Interesado.condicional	15	7	Fearful	46.7%
21	CL	El.racional.subjetivo	8	8	Fearful	40.0%
23	CL	El.gatito.doméstico	8	9	Fearful	33.3%
16	MX	El.inconsciente	12	10	Fearful	57.1%
19	MX	Indeciso	9	11	Fearful	42.9%
24	MX	Valiente	7	12	Fearful	28.6%
25	CL	Eco.startup.er	19	1	Homo.Economicus	73.3%
26	CL	C1	14	2	Homo.Economicus	66.7%
28	CL	Seguidor.de.tendencias	8	3	Homo.Economicus	40.0%
27	MX	El.recién.conectado	14	4	Homo.Economicus	63.6%
29	MX	Perezoso	6	5	Homo.Economicus	27.3%
30	MX	Influencer	12	1	Early.Adopter	66.7%
31	CL	Colaborativo	15	2	Early.Adopter	60.0%
32	CL	El.popular	15	3	Early.Adopter	60.0%
33	CL	P2	16	4	Early.Adopter	53.3%
38	CL	Emprendedor	11	5	Early.Adopter	46.7%
39	CL	El.contradictorio	10	6	Early.Adopter	40.0%
34	CO	Profesional.en.busca.de.sentido	8	7	Early.Adopter	46.7%
35	CO	El.solipsista	14	8	Early.Adopter	46.7%
36	CO	Apresurado	11	9	Early.Adopter	46.7%
37	CO	Centurial	10	10	Early.Adopter	46.7%
40	CO	El.Marginado	7	11	Early.Adopter	26.7%
41	CL	C2	16	1	Careful	66.7%
43	CL	El.empresario.pyme	10	2	Careful	46.7%
46	CL	El.prudente	8	3	Careful	26.1%
42	CO	El.Ágil	15	4	Careful	60.0%
44	CO	Derrotista	10	5	Careful	33.3%
45	CO	E2	9	6	Careful	33.3%
47	MX	Innovador	9	1	Uninterested	62.5%
50	MX	Desinteresado	8	2	Uninterested	37.5%
51	MX	El.ahorrador	7	3	Uninterested	37.5%
48	CO	El.conciente	14	4	Uninterested	53.3%
49	CL	Duro.de.roer	9	5	Uninterested	40.0%
52	CL	Adoptante.temprano	11	1	Influencer	60.0%
53	CL	El.Comodo	13	2	Influencer	46.7%
54	MX	El.olvidado	8	3	Influencer	40.0%
55	MX	Astuto	6	4	Influencer	30.0%
56	MX	Ingenuo	5	5	Influencer	30.0%
57	CO	El.visionario...Aventajado	5	6	Influencer	26.7%
58	CO	Profesional.en.áreas.técnicas.exitoso	9	1	Activist	40.0%
59	CO	J1	5	2	Activist	33.3%

(b) Latin American archetype clusters vs European archetypes

Cluster	European archetypes	MX	CO	CL	Total Clusters	Highest likeness ratio %
1	Stubborn	10	1	1	12	100.0%
2	Fearful	3	4	5	12	86.7%
3	Homo.Economicus	2	0	3	5	73.3%
4	Early.Adopter	1	5	5	11	66.7%
5	Careful	0	3	3	6	66.7%
6	Uninterested	3	1	1	5	62.5%
7	Influencer	3	1	2	6	60.0%
8	Activist	0	2	0	2	40.0%
	Total & Average(%) :	22	17	20	59	69.5%





(b) Latin American archetype clusters vs European archetypes

Cluster	European archetypes	MX	CO	CL	Total Clusters	Highest likeness ratio %
1	Stubborn	10	1	1	12	100.0%
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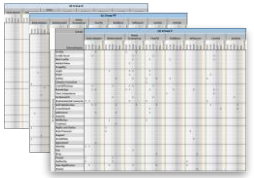
3	Homo.Economicus	2	0	3	5	73.3%
4	Early.Adopter	1	5	5	11	66.7%
5	Careful	0	3	3	6	66.7%
6	Uninterested	3	1	1	5	62.5%
7	Influencer	3	1	2	6	60.0%
8	Activist	0	2	0	2	40.0%
	Total & Average(%) :	22	17	20	59	69.5%

Latin American Archetypes & Consensus on the classification of the determinants in the TTM Stages



- 59 Individual contributions
- 3 Groups
- 8 Archetypes
- 21 collective contributions

	LATAM		
Gropus	**MX**	**CO**	**CL**
Early Adopter	P	P	P
Uninterested	P	P	P
Homo Economicus	P	P	P
Fearful		P	P
Stubborn	P	P	P
Influencer	P	P	P
Careful	P	P	P
Activist		P	

H	Hybrid session with experts
P	Presential session with experts

Context:	Latin American Archetypes **Agreement on the occurrence of factors in more than one TTM stage**							
Archetype	Early Adopter	Uninterested	Homo Economi	Fearful	Stubborn	Influencer	Careful	Activist
TTM Stages*	PF CC PF AC M. RE	PF CC PF AC M. RE	PF CC PF AC M. RE	PF CC PF AC M. RE	PF CC PF AC MAI	PF CC PF AC M. RE	PF CC PF AC M. RE	PF CC PF AC M. RE
32-factor determinants								
Profits	1	1 1	1 2	1 1	1	2	1	1
Credit Score	1 1 1	2	2 1	2	1 1 1		1 1	1
Risk Profile	1	1 1	2 1	2	1		1	
Added Value			1 1 1	1 1	1	1 1	1	
Frugality	1	1 1	2 1	1	2 1		2 1	
Legal	1	1 1	1 1	1 1	1 1 1	1	1 1 1 1	1
Trust	1 1 1 1	1 1	1 1 1	1 1	1 1	1	1	1
Safety	1 1		2	2	2 1 1		1 1 1	1
Climate Protection	1 2 1		1 1		3 1		2 1	1
Cost-Efficiency	1	1	1 1 1	2	1 2	1		1
Knowledge	1 1 1	1 1	1 1	1 1	1 1 1	2	1 1 1	1
Own Competence	2 1		1 1	1 1	1 1 1		1 1	
Technical Fit	1 1 1	1 1	1 1 1	1 1	2	1	1 1 1	1
Environmental Concerns	1 1	1	2	1 1	2		2 1	1
Self-Satisfaction	2 1	1 2	1	1	1 1 1	2	2 1 1	
Commitment	1 1 1	2	1	1	1 1	1	1 1	
Adherence	1 1	2	1 1	1	1 2		1	
Autarky	1	1	1	1	1 1	1	1 1	
Wellbeing	1 1 1	1 1 1	1 1	1 1	1 1 1		1 2 1	
Coziness	1 1	2 1	1	1 1		1	1 1 1	1
Rights and Duties	1 1	2 1	1	1 1	2		1 1 1	
Peer-Pressure	1 1 2	1 2	1	1	1	2	1	
Support	1 1	1	1	1	1 2	1 1	1 1	
Socialising	1 1	2	1	1 1	1 1	1 1	1	
Agreement	1 1	1 1 1		2	1 1	1 1	1 1 1	
Novelty	1 1 1		1	2		1 1	1	1
Fun	1 2			1	1 1	1	1	
Brag	1 2	1 1 1	1 1	1	1	1		
Trends	2 1	2 1	1	1		2	1	1
Authority	1 1	1	1 1 1	1 1	1 1	2	1 2	1
Own Significance	1 1	1	1 1	1	2	1 1	1	
Poseur	1 1	1	1 1	1	1	1		

Latam

WHY

Final archetypes & Consensus on TTM stage

(o) Latin American Archetypes & TTM stages

Consensus on TTM stages

Early Adopter						Uninterested						Homo Economicus						Fearful						Stubborn						Influencer						Careful						Activist					
PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL	PREC	CON	PREP	ACT	MAI	REL
							X						X									X									X																X	
		X										X							X							X												X					X				
							X							X					X																											
													X									X										X															
							X						X											X														X										
								X					X						X						X						X						X							X			
	X						X							X				X										X		X												X					
		X													X							X			X													X							X			
		X											X														X									X						X					
														X					X									X			X															X	
		X								X		X								X					X								X					X							X		
X														X						X						X													X								
		X							X				X						X							X						X						X							X		
X												X							X					X													X						X					
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		X								X											X					X								X													
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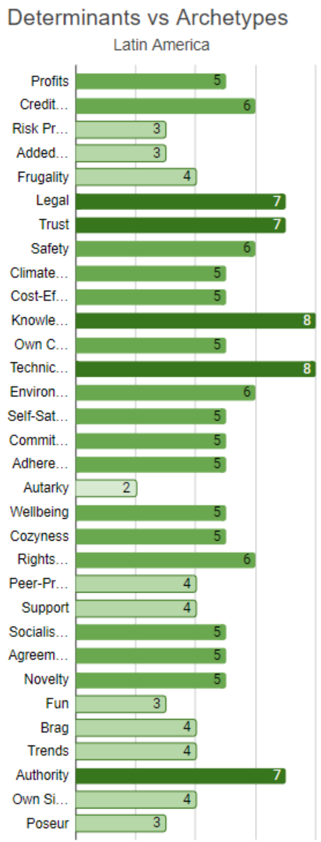
				X																						X				X																	
				X			X									X														X																	
X									X																					X													X				
		X										X									X			X										X					X					X			
X														X										X										X													
				X								X																					X														

ARCHETYPES

Early Adopter	Uninterested	Homo Economicus	Fearful	Stubborn	Influencer	Careful	Activist	Total
	1	1	1		1		1	5
1		1	1	1		1	1	6
	1	1	1					3
		1	1		1			3
	1	1		1		1		4
	1	1	1	1	1	1	1	7
1	1	1	1	1	1		1	7
1		1	1	1		1	1	6
1		1		1		1	1	5
		1	1	1	1		1	5
1	1	1	1	1	1	1	1	8
1		1	1	1		1		5
1	1	1	1	1	1	1	1	8
1		1	1	1		1	1	6
1	1			1	1	1		5
1	1			1	1	1		5
1	1	1		1		1		5
					1	1		2
1	1		1	1		1		5
	1		1		1	1	1	5
1	1	1	1	1		1		6
1	1		1		1			4
1				1	1	1		4
1	1		1	1	1			5
	1		1	1	1	1		5
1			1		1	1	1	5
1				1	1			3
1	1	1			1			4
1	1				1		1	4
1		1	1	1	1	1	1	7
1		1		1	1			4
1		1			1			3

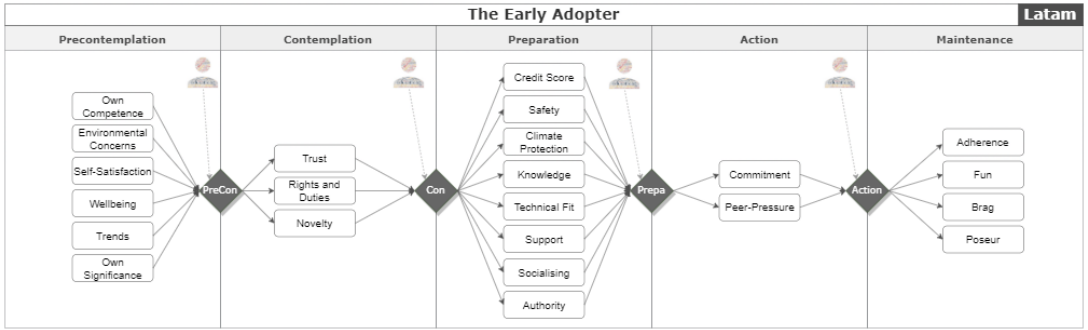


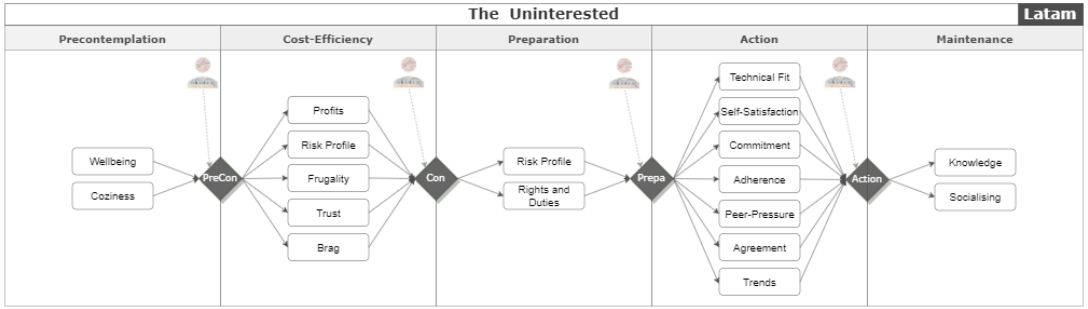
Determinants vs TTM-Stages

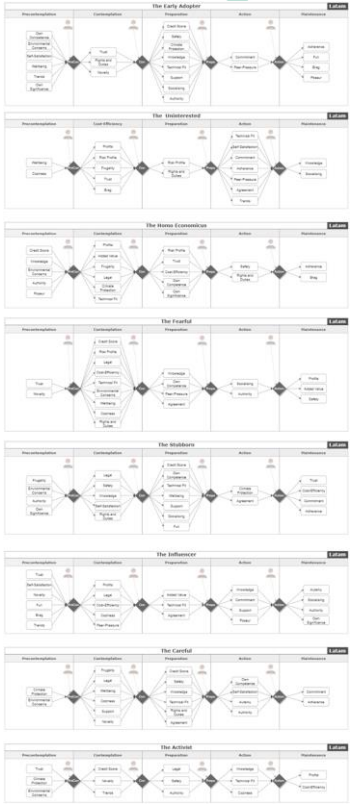
PREC	CON	PREP	ACT	MAI	RELAPSE
	3			2	
1	2	3			
	2	1			
	1	1		1	
1	3				
	5	2			
3	2	1		1	
	1	3	1	1	
2	1	1	1		
	2	1		2	
1	1	3	2	1	
1		3	1		
	2	4	2		
5	1				
2	1		2		
			3	2	
			1	4	
			1	1	
2	2	1			
1	3		1		
	3	2	1		
	1	1	2		
	1	2	1		
		2	1	2	
		3	2		
2	3				
1		1		1	
1	1			2	
2	1		1		
2		2	2	1	
2		1		1	
1			1	1	

EU

Causal diagrams





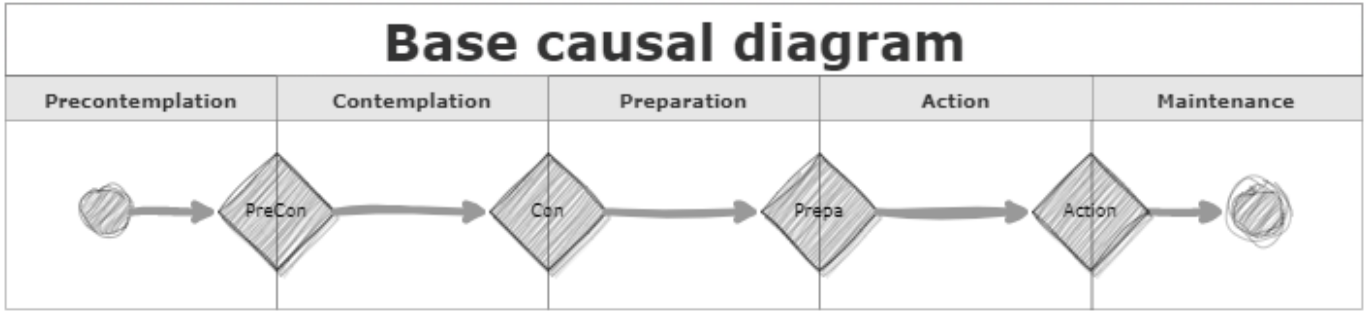


6. Contributions

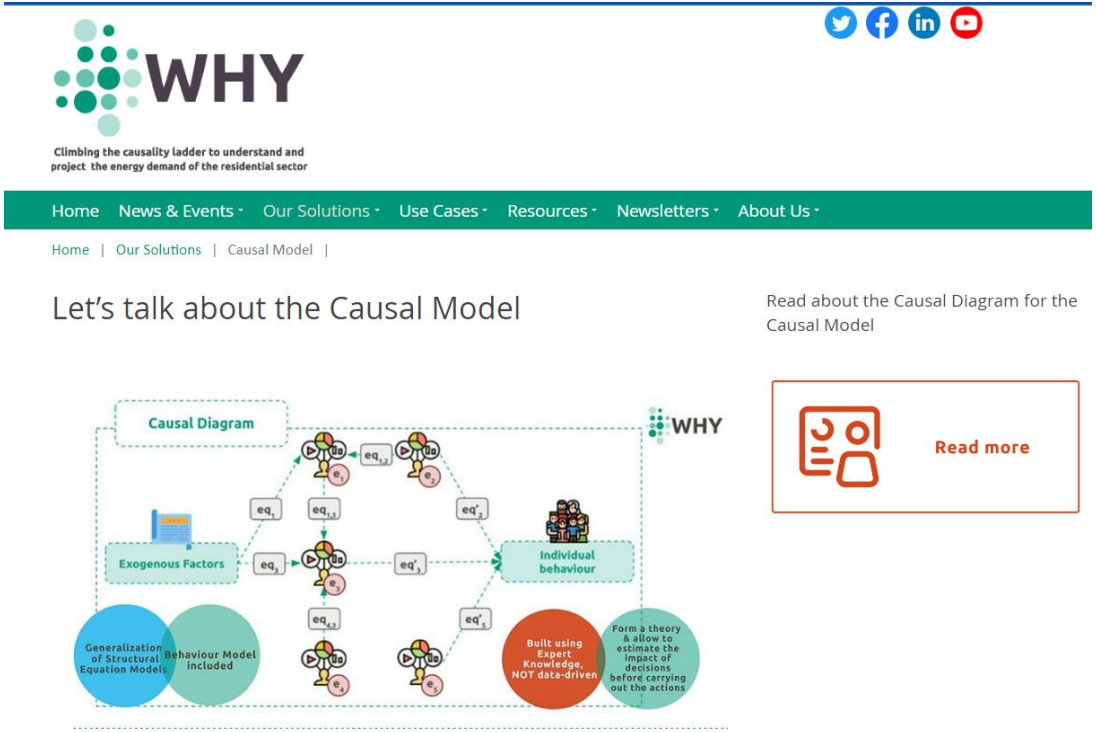
Contributions

- **Artificial intelligence** by introducing a **methodology** for expressing explicit assumptions.
- It extends **theories of human behaviour** and contributes a **taxonomy** for decision-making factors in the context of the energy transition. Furthermore, it has applications for **public policy,** as it allows for designing interventions and estimating their impact on target archetypes.
- The resulting causal models will eventually be integrated into the **WHY toolkit** for:
  - Assessing several scenarios simulating different policy measures;
  - Will provide a module to define scenarios of possible different developments of the causal model over time, fully considering new services and user needs that may emerge in the future.
- In the context of climate change, the use case benchmarks range causal models from local to European-wide energy grids.

Causal Modelling

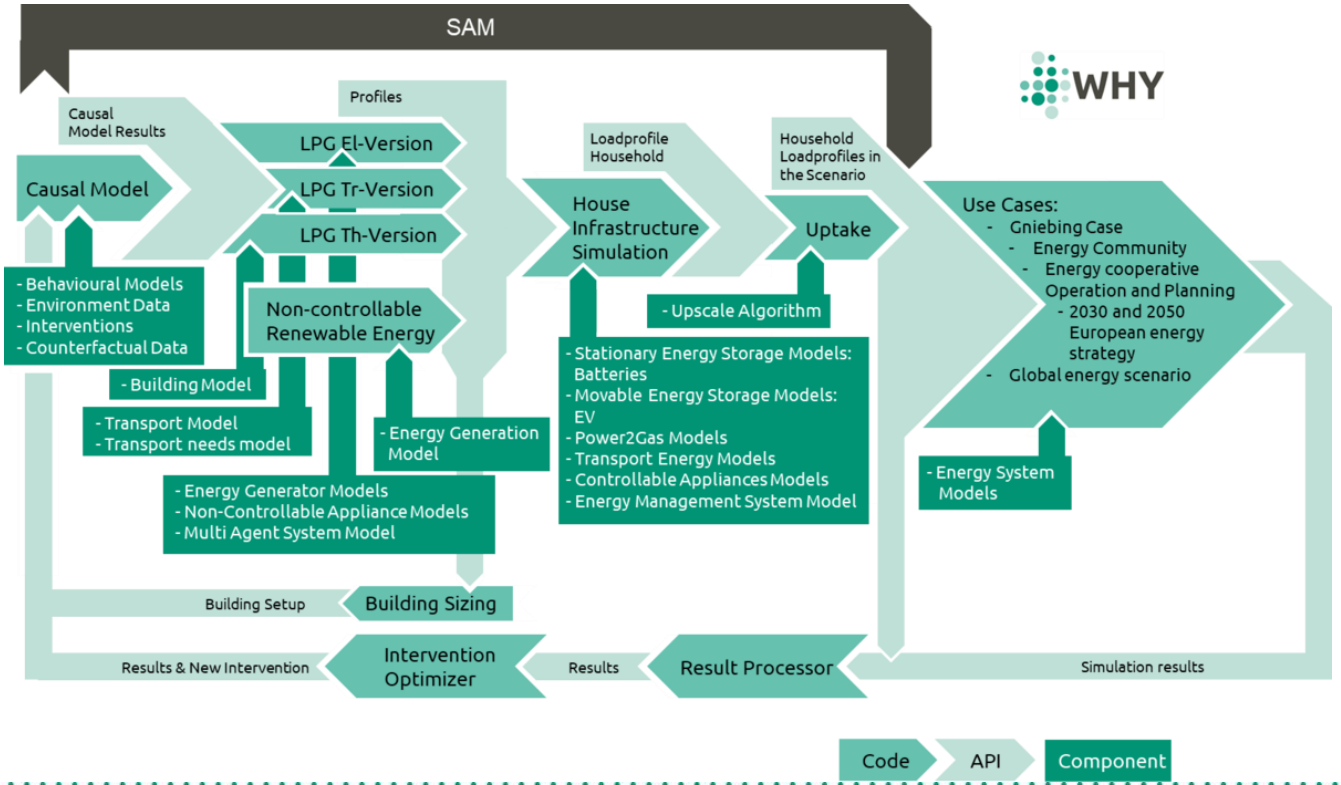


WHY project website



7. Future work

The WHY Toolkit - What would be if...



Thank you very much!

What if you do X?

What if you don't?

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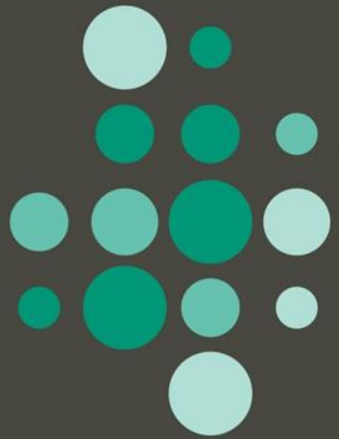

WHY

CLIMBING THE CAUSALITY LADDER TO UNDERSTAND
THE ENERGY DEMAND ON THE RESIDENTIAL SECTOR

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