

ODD+D protocol for agent based simulation model PVact **Appendix**

Contents

1	Overview	1
2	List of Tables	2
3	File structure	4
3.1	Spatial Data Input File	4
3.2	Techno-economic Product Data Input File	7
3.3	Diffusion Data Input File	12
3.4	End Of Year output file	15
3.5	Neighbourhood output file	17
3.6	Adoption overview output file	19
3.7	Quantile output file	22
3.8	Bucket output file	24
3.9	Communication event output file	26
3.10	Adoption comparison output file	28
3.11	Zip-code-based adoption comparison output file	30
3.12	Agent phase overview output file	32
3.13	Interest development output file	34
4	Parameters	36

1 Overview

This file describes the structure of all input and output files used in PVact. The following structure is used:

- Table with an overview over all sheets, a short content description and a reference to to table description itself.
- One table per sheet, which provides an overview over all fields.
- (Optional) Table with example data

2 List of Tables

1	Spatial Data File Overview	4
2	Spatial Data Sheet Description	4
3	Spatial Data File Example	6
4	Techno-economic Product Data File Overview	7
5	Techno-economic Product Data General Sheet Description	7
6	Techno-economic Product Data Inclination Sheet Description . .	8
7	Techno-economic Product Data Inclination Sheet Example	8
8	Techno-economic Product Data Orientation Sheet Description . .	9
9	Techno-economic Product Data Orientation Sheet Example	9
10	Techno-economic Product Data Electricity Sheet Description . .	10
11	Techno-economic Product Data Electricity Sheet Example	10
12	Techno-economic Product Data Efficiency Sheet Description . . .	11
13	Techno-economic Product Data Electricity Sheet Example	11
14	Diffusion Data File Overview	12
15	Diffusion Data Annual Adoptions Sheet Description	12
16	Diffusion Data Annual Adoptions Sheet Example	13
17	Diffusion Data Running Totals Sheet Description	13
18	Diffusion Data Running Totals Sheet Example	13
19	End Of Year Logger File Overview	15
20	End Of Year Logger File Description	15
21	End Of Year Logger File Example	16
22	Neighbourhood File Overview	17
23	Neighbourhood File Description	17
24	Neighbourhood File Example	18
25	Adoption Overview File Overview	19
26	Adoption Overview File Description	19
27	Adoption Overview File Example	20
28	Quantile File Overview	22
29	Quantile File Description	22
30	Quantile File Example	23
31	Bucket File Overview	24
32	Bucket File Description	24
33	Bucket File Example (delta = 0.1)	24
34	Communication File Overview	26
35	Communication File Description	26
36	Communication File Example	27
37	Annual Adoptions File Overview	28
38	Annual Adoptions File Description	28
39	Annual Adoptions File Example	28
40	Annual Adoptions (ZIP) File Overview	30
41	Annual Adoptions (ZIP) File Description	30

42	Annual Adoptions (ZIP) File Example	30
43	Process Model Phases File Overview	32
44	Process Model Phases File Description	32
45	Process Model Phases File Example	32
46	Interest Development File Overview	34
47	Interest Development File Description	34
48	Interest Development File Example	34
49	Parameter Overview	36
50	Consumer Agent Group Affinities Matrix	50

3 File structure

3.1 Spatial Data Input File

Table 1: Spatial Data File Overview

Table name	Description	Table
Spatial Data	General parameters	2

4

Table 2: Spatial Data Sheet Description

Field name	Variable type	Description	Format
ID	ID	serial number	int
Address	text	street and house number	varchar
Zip code	text	zip code of the address	varchar
Owner type	categorical	type of owner of the property	varchar
	Characteristic	Characteristic description	
	Private	ownership is private	
	City of Leipzig	owner is city of Leipzig	
	Municipal company	owner is a municipal company	
	Other	owner is someone else	
Private owner	categorical	binary indicator indicator of whether the property is private	int
	Characteristic	Characteristic description	

Spatial Data Sheet Description

Field name	Variable type	Description	Format
	0	ownership is not private	
	1	ownership is private	
Households	number	number of households registered at address	int
Small household	categorical	binary household indicator whether the household is small ((semi-detached house)	int
	Characteristic	Characteristic description	
	0	household is not small (Haushalte > 2)	
	1	household is small (Haushalte ≤ 2)	
Income	number	income in €	int
Milieu	categorical	dominant Sinus® Milieu	varchar
	Characteristic	Characteristic description	
	BUM	Sinus® milieu	
	EPE	Sinus® milieu	
	HED	Sinus® milieu	
	KET	Sinus® milieu	
	LIB	Sinus® milieu	
	PER	Sinus® milieu	
	PRA	Sinus® milieu	
	PRE	Sinus® milieu	
	SOK	Sinus® milieu	
	TRA	Sinus® milieu	
Rooftop orientation	number	assumption gabled roof, 90°=North/South, 0°=East/West	int
Rooftop inclination	number	assumption gabled roof, 0°=vertical, 90°=horizontal	int

Spatial Data Sheet Description

Field name	Variable type	Description	Format
Area	number	base area of the building polygon	decimal
X-Centroid	coordinate	longitude in WGS84	decimal
Y-Centroid	coordinate	latitude in WGS84	decimal

Table 3: Spatial Data File Example

ID	Address	Zip code	Owner type	Private owner	Households	Small households	Income	Milieu	Rooftop orientation	Rooftop inclination	Area	X-Cen- troid	Y-Cen- troid
1	Street 1	01234	Privat	1	2	1	12345	BUM	30	60	123	12.5	50.5
2	Street 2	01235	Andere	0	4	0	54321	LIB	0	0	321	12.3	50.3
3	Street 3	01236	Stadt Leipzig	0	1	1	12321	PRA	90	60	111	12.7	50.7
...

3.2 Techno-economic Product Data Input File

Table 4: Techno-economic Product Data File Overview

Table name	Description	Table
General	General parameters	5
Inclination	Inclination data	6
Orientation	Orientation data	8
Electricity	Electricity data	10
Efficiency	Efficiency data	12

7

Table 5: Techno-economic Product Data General Sheet Description

Field name	Variable type	Description	Format
p	number	price increase - average annual increase in electricity prices between 2006 and 2020	decimal
D	number	degradation - average annual degradation of PV systems	decimal
SC	number	self-consumption ratio - average self-consumption ratio	decimal
t _{FIT}	number	investment horizon - calculation horizon, based on 20 years guaranteed feed-in tariff	int

Table 6: Techno-economic Product Data Inclination Sheet Description

Field name	Variable type	Description	Format
Rooftop inclination	number series	angle of inclination of a surface, 0°=vertical, 90°=horizontal	decimal
Solar irradiation	number series	solar irradiation per inclination - average annual global radiation in kWh per 6m ² area with inclination N at south orientation; calculated based on monthly values of the years 2010-2016 in Leipzig.	decimal

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Table 7: Techno-economic Product Data Inclination Sheet Example

Rooftop inclination	Solar irradiation
0	1000
1	2000
2	4000
...	...
90	3000

Table 8: Techno-economic Product Data Orientation Sheet Description

Field name	Variable type	Description	Format
Rooftop orientation	number series	rooftop orientation - orientation of a surface, 90°=North/South orientation (optimal), 0°=East/West orientation	decimal
Adjustment factor	number series	adjustment factor per orientation - factor for reduction of the amount of radiation by deviation from south orientation	decimal

Table 9: Techno-economic Product Data Orientation Sheet Example

Rooftop orientation	Adjustment factor
0	0.5
1	0.7
2	0.6
...	...
90	1.0

Table 10: Techno-economic Product Data Electricity Sheet Description

Field name	Variable type	Description	Format
Year	number series	year of calculation	int
Investment cost	number series	price per kW _{peak} in €	decimal
Electricity price	number series	electricity price per kWh in €	decimal
Feed-in tariff	number series	feed-in tariff for small plant in €	decimal
Interest rate	number series	interest rate for risk-free savings deposits in Germany	decimal

Table 11: Techno-economic Product Data Electricity Sheet Example

Year	Investment cost	Electricity price	Feed-in tariff	Interest rate
2005	4000	0.1	0.5	2.1
2006	3000	0.15	0.45	2.3
2007	2800	0.2	0.4	2.0
...

Table 12: Techno-economic Product Data Efficiency Sheet Description

Field name	Variable type	Description	Format
Year	number series	year of calculation	int
Module efficiency	number series	average efficiency under laboratory conditions (laboratory efficiency)	decimal
Performance ratio	number series	factor for reduction of efficiency due to shading, pollution, maintenance, conduction, etc. (real efficiency)	decimal

Table 13: Techno-economic Product Data Electricity Sheet Example

Year	Module efficiency	Performance ratio
2005	15.0	80.0
2006	15.2	80.6
2007	15.4	81.3
...

3.3 Diffusion Data Input File

Table 14: Diffusion Data File Overview

Table name	Description	Table
Annual adoptions	Contains the number of adoptions per zip code and year in matrix layout. It is important to note that the year columns depend on the data actually used. The years shown here are based on the data used for the case of Leipzig.	15
Running totals	Contains the running totals of adoptions per zip code and year in matrix layout. The running totals are derived from the values in table Annual adoptions . Likewise, the years here are based on the example of Leipzig.	17

12

Table 15: Diffusion Data Annual Adoptions Sheet Description

Field name	Variable type	Description	Format
ZIP	text series	zip codes	varchar
1904	number series	Number of adoptions in 1904 per zip code.	int
1993	number series	Number of adoptions in 1993 per zip code.	int
...			
2020	number series	Number of adoptions in 2020 per zip code.	int

Table 16: Diffusion Data Annual Adoptions Sheet Example

ZIP	1904	1993	1994	...
01230	0	2	2	...
01231	1	2	0	...
01232	1	0	1	...
...

Table 17: Diffusion Data Running Totals Sheet Description

Field name	Variable type	Description	Format
ZIP	text series	zip codes	varchar
1904	number series	Number of adoptions in 1904 per zip code.	int
1993	number series	Sum of adoptions until 1993 per zip code.	int
...			
2020	number series	Sum of adoptions until 2020 per zip code.	int

Table 18: Diffusion Data Running Totals Sheet Example

ZIP	1904	1993	1994	...
01230	0	2	4	...
01231	1	3	3	...

Diffusion Data Running Totals Sheet Example

ZIP	1904	1993	1994	...
01232	1	1	2	...
...

3.4 End Of Year output file

Table 19: End Of Year Logger File Overview

Table name	Description	Table
Data	The agents' data logged at the end of each year.	20

Table 20: End Of Year Logger File Description

Field name	Variable type	Description	Format
Agent	text	name of the agent	varchar
ID	ID	agent id	int
Product	text	name of the product	varchar
Date	datetime	date and time of the logged event	yyyy-MM-dd'T'HH:mm:ss
Value	number	logged value	decimal
NaN	categorical	determines if Wert is valid or NaN (not a number)	bool
	Characteristic	Characteristic description	
	false	value is valid	
	true	value is NaN	

Table 21: End Of Year Logger File Example

Agent	ID	Product	Date	Value	NaN
BUM_1	1	PV	2007-01-01T12:00:00	10	false
TRA_12	1234	PV	2008-10-10T12:00:00	0	true
...

3.5 Neighbourhood output file

Table 22: Neighbourhood File Overview

Table name	Description	Table
Data	Logs the local neighbourhood of each agent. The neighbourhood contains all agents that are within the <i>distance filter</i> . The distance between agents depends on the used <i>distance metric</i> (generally whether the distance is in meters or kilometers). The number of columns depends on the largest neighbourhood. The agents in a neighborhood are sorted by distance. Primarily used for debugging.	23

17

Table 23: Neighbourhood File Description

Field name	Variable type	Description	Format
Agent	text	Name of the reference agent	varchar
Size	number	Size of the neighbourhood of Agent	int
Agent_1	text	Name of the first agent	varchar
Distance_1	number	Distance between Agent and Agent_1	
...			
Agent_Size	text	Name of the last agent	varchar
Distance_Size	number	Distance between Agent and Agent_Size	decimal

Table 24: Neighbourhood File Example

Agent	Size	Agent_1	Distance_1	Agent_2	Distance_2	...
BUM_1	5	LIB_12	123	TRA_1	321	...
BUM_2	0					
BUM_3	1	PRA_32	100			
...

3.6 Adoption overview output file

Table 25: Adoption Overview File Overview

Table name	Description	Table
Data	Logs the adoption events for each agent and product. Primarily used for debugging.	26

Table 26: Adoption Overview File Description

Field name	Variable type	Description	Format
Agent	text	Name of the agent	varchar
Id	ID	agent id	int
Milieu	categorical	dominant Sinus Milieu	varchar
	Characteristic	Characteristic description	
	BUM	Sinus [®] milieu	
	EPE	Sinus [®] milieu	
	HED	Sinus [®] milieu	
	KET	Sinus [®] milieu	
	LIB	Sinus [®] milieu	
	PER	Sinus [®] milieu	
	PRA	Sinus [®] milieu	
	PRE	Sinus [®] milieu	
	SOK	Sinus [®] milieu	

Adoption Overview File Description

Field name	Variable type	Description	Format
	TRA	Sinus [®] milieu	
Address	text	address - street and number	varchar
ZIP code	text	zip code	varchar
Income	number	income in €	int
Utility	number	Utility U at the time of adoption. The value is undefined for initial adopter.	decimal
Product	text	Name of the adopted product	varchar
Date	datetime	Date and time of the adoption event	yyyy-MM-dd'T'HH:mm:ss
Adoption phase	categorical	Time phase in which the adoption took place	varchar
	Characteristic	Characteristic description	
	INITIAL	Adoption took place before the simulation	
	START_MID	Adoption took place between January 1 and before the middle of the year.	
	MID_END	Adoption took place between the middle of the year and December 31.	
	END_START	The adoption took place at the turn of the year.	

Table 27: Adoption Overview File Example

Agent	ID	Milieu	Address	ZIP code	Income	Utility	Product	Date	Adoption phase
BUM_1	1	BUM	Street 1	01234	123	0.7	PV	2008-04-10T12:00:00	START_MID
TRA_11	122	TRA	Street 12	01235	321	0.5	PV		INITIAL

Adoption Overview File Example

Agent	ID	Milieu	Address	ZIP code	Income	Utility	Product	Date	Adoption phase
SOK_23	3333	SOK	Street 42	01237	123	0.7	PV	2008-12-10T12:00:00	MID_END
...

3.7 Quantile output file

Table 28: Quantile File Overview

Table name	Description	Table
Data	Calculates the average for each of the six quantiles ([0,10), [10,25), [25,50), [50,75), [75,90), [90,100)) in each simulation year. Primarily used for image generation.	29

Table 29: Quantile File Description

Field name	Variable type	Description	Format
Year	time	The observed year.	int
avg	number	The average of all values.	decimal
[0,10)	number	Average of the values from the [0,10) quantile.	decimal
[10,25)	number	Average of the values from the [10,25) quantile.	decimal
[25,50)	number	Average of the values from the [25,50) quantile.	decimal
[50,75)	number	Average of the values from the [50,75) quantile.	decimal
[75,90)	number	Average of the values from the [75,90) quantile.	decimal
[90,100)	number	Average of the values from the [90,100) quantile.	decimal

Table 30: Quantile File Example

Year	avg	[0,10)	[25,50)	[50,75)	[75,90)	[90,100)
2005	0.3	0.11	0.24	0.39	0.7	0.96
2006	0.45	0.12	0.27	0.45	0.78	0.95
2007	0.42	0.1	0.3	0.49	0.77	0.98
...

3.8 Bucket output file

Table 31: Bucket File Overview

Table name	Description	Table
Data	Divides the observed values in each year into buckets of specified size (<code>delta</code>). The observed values are sorted, starting with <code>min</code> and ending with <code>max</code> . The number of columns depends on these three values. Primarily used for image generation.	32

Table 32: Bucket File Description

Field name	Variable type	Description	Format
Year	time	The observed year.	int
avg	number	The average of all values for the corresponding year.	decimal
[min, min+delta)	number	The average of all values within the bucket for the corresponding year.	decimal
...			
[max-delta, max)	number	The average of all values within the bucket for the corresponding year.	decimal

Table 33: Bucket File Example ($\text{delta} = 0.1$)

Year	avg	[0,0.1)	...	[1.7,1.8)
2005	0.3	0.04	...	1.76

Bucket File Example ($\delta = 0.1$)

Year	avg	[0,0.1)	...	[1.7,1.8)
2006	0.45	0.07	...	1.72
2007	0.42	0.03	...	1.79
...

3.9 Communication event output file

Table 34: Communication File Overview

Table name	Description	Table
Data	Logs every communication event and the value changes of the relative agreement algorithm. Primarily used for debugging.	35

Table 35: Communication File Description

Field name	Variable type	Description	Format
Date	datetime	Date and time of the logged event	yyyy-MM-dd'T'HH:mm:ss
Attribute	text	Corresponding agent attribute	varchar
Mode	categorical	The applied relative agreement modulus.	varchar
	Characteristic	Characteristic description	
	NEUTRAL	Nothing happened	
	CONVERGENCE	Relative agreement is applied	
	DIVERGENCE	Reverse relative agreement is applied	
Agent_i	text	Name of the first agent	varchar
x_i	number	Agent_i's opinion of Attribute	decimal
u_i	number	Agent_i's uncertainty of Attribute	decimal
new x_i	number	Agent_i's new opinion of Attribute	decimal
Agent_j	text	Name of the second agent	varchar

Communication File Description

Field name	Variable type	Description	Format
x _j	number	Agent _j 's opinion of Attribute	decimal
u _j	number	Agent _j 's uncertainty of Attribute	decimal
new x _j	number	Agent _j 's new opinion of Attribute	decimal

Table 36: Communication File Example

Date	Attribute	Mode	Agent _i	x _i	u _i	new x _i	Agent _j	x _j	u _j	new x _j
2007-01-01T12:00:00	novelty seeking	NEUTRAL	BUM_1	0.3	0.2	0.3	TRA_12	0.4	0.2	0.4
2007-01-01T12:00:00	environmental concern	DIVERGENCE	BUM_1	0.34	0.3	0.33	TRA_12	0.36	0.3	0.37
2007-01-03T12:00:00	novelty seeking	CONVERGENCE	BUM_3	0.3	0.2	0.32	EPE_12	0.4	0.2	0.39
2007-01-03T12:00:00	environmental concern	CONVERGENCE	BUM_3	0.34	0.3	0.35	EPE_12	0.36	0.3	0.35
...

3.10 Adoption comparison output file

Table 37: Annual Adoptions File Overview

Table name	Description	Table
Data	Calculates the simulated and real adoptions for each simulation year. Primarily used for image generation.	38

Table 38: Annual Adoptions File Description

Field name	Variable type	Description	Format
Year	time	The simulated year	int
Simulation	number	Simulated number of adoptions	int
Real	number	Real number of adoptions	int

Table 39: Annual Adoptions File Example

Year	Simulation	Real
2005	4	3
2006	3	4
2007	5	7

Annual Adoptions File Example

Year	Simulation	Real
...

3.11 Zip-code-based adoption comparison output file

Table 40: Annual Adoptions (ZIP) File Overview

Table name	Description	Table
Data	Calculates the simulated and real adoptions for each simulation year based on zip codes. The number of columns depends on the number of zip codes. Primarily used for image generation.	41

30

Table 41: Annual Adoptions (ZIP) File Description

Field name	Variable type	Description	Format
Year	time	The simulated year	int
<i>zip</i>	number	Simulated number of adoptions for zip code <i>zip</i>	int
<i>zip</i> -Real	number	Real number of adoptions for zip code <i>zip</i>	int
...			

Table 42: Annual Adoptions (ZIP) File Example

Year	01234	01234-Real	01235	01235-Real	...
2005	1	0	2	1	...

Annual Adoptions (ZIP) File Example

Year	01234	01234-Real	01235	01235-Real	...
2006	0	2	1	1	...
2007	1	3	4	3	...
...

3.12 Agent phase overview output file

Table 43: Process Model Phases File Overview

Table name	Description	Table
Data	Logs the phase each agent is in at the end of a simulation year. Primarily used for image generation.	44

Table 44: Process Model Phases File Description

Field name	Variable type	Description	Format
Year	time	The simulated year	int
Initial adopted	number	Number of agents in Initial adopted state.	int
Awareness	number	Number of agents in Awareness state.	int
Feasibility	number	Number of agents in Feasibility state.	int
Decision Making	number	Number of agents in Decision Making state.	int
Adopted	number	Number of agents in Adopted state.	int

Table 45: Process Model Phases File Example

Year	Initial adopted	Awareness	Feasibility	Decision Making	Adopted
2005	12	33	11	44	50

Process Model Phases File Example

Year	Initial adopted	Awareness	Feasibility	Decision Making	Adopted
2006	12	22	22	39	55
2007	12	22	11	35	70
...

3.13 Interest development output file

Table 46: Interest Development File Overview

Table name	Description	Table
Data	Logs the interest level for PV for each agent at the end of a simulation year. The number of columns depends on the different interest values. Primarily used for image generation.	47

Table 47: Interest Development File Description

Field name	Variable type	Description	Format
Year	time	The simulated year	int
int_{\min}	number	The smallest interest level	int
...			
int_{\max}	number	The largest interest level	int

Table 48: Interest Development File Example

Year	0	...	10
2005	70	...	0
2006	57	...	3

Interest Development File Example

Year	0	...	10
2007	50	...	11
...

4 Parameters

Table 49: Parameter Overview

Name	Short	Type	Description	Dimension	Format
Files					
spatial data		file			xlsx
	Reference Value:		Datensatz_L.xlsx		
techo-economic product data		file			xlsx
	Reference Value:		Barwertrechner_L.xlsx		
diffusion data		file			xlsx
	Reference Value:		PV_Diffusion_L.xlsx		
Agents (global)					
population size	pop	number	based on spatial data file	\mathbb{N}	int
	Reference Value:		47,731		
coverage		number	describes the coverage of the spatial data file in relation to the real data	$x \in \mathbb{R} 0 \leq x \leq 1$	decimal
	Reference Value:		0.696375945		
rate construction	r_{const}^{year}	time series	annual construction rate of 1-2 family houses, based on total residential building stock	$x \in \mathbb{R} 0 \leq x \leq 1$	decimal
	Characteristic		Characteristic description		
	2008		0.00364015558626337		
	2009		0.003144678138942		
	2010		0.00310149814685168		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	2011		0.00353613327878839		
	2012		0.00352455261653549		
	2013		0.00386110580259704		
	2014		0.00429010958187084		
	2015		0.00379815315270396		
	2016		0.00497070832593645		
	2017		0.00409967647131461		
	2018		0.00411108283512271		
	2019		0.00438894416886053		
	2020		0.0044289612161372		
rate renovation	r_{reno}^{year}	time series	annual renovation rate of total residential building stock	$x \in \mathbb{R} 0 \leq x \leq 1$	decimal
	Characteristic		Characteristic description		
	2008		0.00394339526076053		
	2009		0.00365838113448056		
	2010		0.00328192122626706		
	2011		0.00340568137058094		
	2012		0.00341602718688205		
	2013		0.00383218837066616		
	2014		0.0038468233028334		
	2015		0.00341422431416348		
	2016		0.00403218297768271		
	2017		0.00344274036205577		
	2018		0.00336238383793679		
	2019		0.00388714073628027		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	2020		0.00329614110309881		
Consumer agent group (cag)					
environmental concern	<i>ec</i>	distribution	agents attitude towards the environment	\mathbb{R}	decimal
	Characteristic		Characteristic description		
	BUM		truncated normal distribution in $[0, 1]$ with $\mu = 0.72098352$ and $\sigma = 0.151834724$		
	EPE		truncated normal distribution in $[0, 1]$ with $\mu = 0.746611134$ and $\sigma = 0.131716696$		
	HED		truncated normal distribution in $[0, 1]$ with $\mu = 0.686212698$ and $\sigma = 0.177211469$		
	KET		truncated normal distribution in $[0, 1]$ with $\mu = 0.722351721$ and $\sigma = 0.15589877$		
	LIB		truncated normal distribution in $[0, 1]$ with $\mu = 0.746942099$ and $\sigma = 0.1469412$		
	PER		truncated normal distribution in $[0, 1]$ with $\mu = 0.750483784$ and $\sigma = 0.15294908$		
	PRA		truncated normal distribution in $[0, 1]$ with $\mu = 0.737546946$ and $\sigma = 0.150078226$		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	PRE		truncated normal distribution in $[0, 1]$ with $\mu = 0.695360195$ and $\sigma = 0.179601083$		
	SOK		truncated normal distribution in $[0, 1]$ with $\mu = 0.791276615$ and $\sigma = 0.140908223$		
	TRA		truncated normal distribution in $[0, 1]$ with $\mu = 0.745993586$ and $\sigma = 0.173108196$		
novelty seeking	<i>ns</i>	distribution	agents attitude towards new products	\mathbb{R}	decimal
	Characteristic		Characteristic description		
	BUM		truncated normal distribution in $[0, 1]$ with $\mu = 0.418478262$ and $\sigma = 0.216839083$		
	EPE		truncated normal distribution in $[0, 1]$ with $\mu = 0.459394907$ and $\sigma = 0.205263117$		
	HED		truncated normal distribution in $[0, 1]$ with $\mu = 0.476092895$ and $\sigma = 0.222675603$		
	KET		truncated normal distribution in $[0, 1]$ with $\mu = 0.469977553$ and $\sigma = 0.209684591$		
	LIB		truncated normal distribution in $[0, 1]$ with $\mu = 0.440444645$ and $\sigma = 0.224698364$		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	PER		truncated normal distribution in $[0, 1]$ with $\mu = 0.538128934$ and $\sigma = 0.212903502$		
	PRA		truncated normal distribution in $[0, 1]$ with $\mu = 0.493895967$ and $\sigma = 0.224942382$		
	PRE		truncated normal distribution in $[0, 1]$ with $\mu = 0.334325395$ and $\sigma = 0.249955992$		
	SOK		truncated normal distribution in $[0, 1]$ with $\mu = 0.369047621$ and $\sigma = 0.212907301$		
	TRA		truncated normal distribution in $[0, 1]$ with $\mu = 0.335937498$ and $\sigma = 0.219753169$		
rate rewire	r_{rew}	distribution	probability to delete and create a new edge in the social network of a milieu member	$x \in \mathbb{R} 0 \leq x \leq 1$	decimal
	Characteristic		Characteristic description		
	BUM		dirac distribution with $\delta = 0.005$		
	EPE		dirac distribution with $\delta = 0.01$		
	HED		dirac distribution with $\delta = 0.01$		
	KET		dirac distribution with $\delta = 0.005$		
	LIB		dirac distribution with $\delta = 0.0075$		
	PER		dirac distribution with $\delta = 0.01$		
	PRA		dirac distribution with $\delta = 0.0075$		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	PRE		dirac distribution with $\delta = 0.005$		
	SOK		dirac distribution with $\delta = 0.0075$		
	TRA		dirac distribution with $\delta = 0.0025$		
rate communicate	r_{com}	distribution	probability of a milieu member to seek an agent in the social network to communicate with	$x \in \mathbb{R} 0 \leq x \leq 1$	decimal
	Characteristic		Characteristic description		
	BUM		dirac distribution with $\delta = 0.192$		
	EPE		dirac distribution with $\delta = 0.210$		
	HED		dirac distribution with $\delta = 0.206$		
	KET		dirac distribution with $\delta = 0.204$		
	LIB		dirac distribution with $\delta = 0.203$		
	PER		dirac distribution with $\delta = 0.214$		
	PRA		dirac distribution with $\delta = 0.216$		
	PRE		dirac distribution with $\delta = 0.145$		
	SOK		dirac distribution with $\delta = 0.191$		
	TRA		dirac distribution with $\delta = 0.174$		
network size	e	distribution	number of edges in the social networks of milieu members	\mathbb{N}_0	int
	Characteristic		Characteristic description		
	BUM		dirac distribution with $\delta = 13$		
	EPE		dirac distribution with $\delta = 14$		
	HED		dirac distribution with $\delta = 14$		
	KET		dirac distribution with $\delta = 16$		
	LIB		dirac distribution with $\delta = 16$		
	PER		dirac distribution with $\delta = 16$		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	PRA		dirac distribution with $\delta = 14$		
	PRE		dirac distribution with $\delta = 12$		
	SOK		dirac distribution with $\delta = 14$		
	TRA		dirac distribution with $\delta = 13$		
affinity	a_{cag_i, cag_j}	vector	composition of the social networks of milieu members	$a_{cag_i, cag_j} \in \mathbb{R}_{\geq 0}, \sum_j a_{cag_i, cag_j} = 1$	decimal
	Characteristic		Characteristic description		
	BUM		see table 50		
	EPE		see table 50		
	HED		see table 50		
	KET		see table 50		
	LIB		see table 50		
	PER		see table 50		
	PRA		see table 50		
	PRE		see table 50		
	SOK		see table 50		
	TRA		see table 50		
Consumer agent (household)					
street adresse		text	street and house number		varchar
zip code	<i>zip</i>	text	zip code		varchar
owner type	<i>ot</i>	categorical	binary ownership indicator	0, 1	int
	Characteristic		Characteristic description		
	0		ownership is not private		
	1		ownership is private		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
households	h	categorical	binary household indicator	0, 1	int
	Characteristic		Characteristic description		
	0		household is not small		
	1		household is small		
income		number	income in €		int
milieu		categorical	dominant Sinus Milieu		varchar
	Characteristic		Characteristic description		
	BUM		Sinus [®] milieu		
	EPE		Sinus [®] milieu		
	HED		Sinus [®] milieu		
	KET		Sinus [®] milieu		
	LIB		Sinus [®] milieu		
	PER		Sinus [®] milieu		
	PRA		Sinus [®] milieu		
	PRE		Sinus [®] milieu		
	SOK		Sinus [®] milieu		
	TRA		Sinus [®] milieu		
rooftop orientation	$roof_o$	number	rooftop orientation, assumption gabled roof, 90°=North/South, 0°=East/West	$x \in \mathbb{R} 0 \leq x \leq 90$	int
rooftop inclination	$roof_i$	number	rooftop inclination, assumption gabled roof, 0°=vertical, 90°=horizontal	$x \in \mathbb{R} 0 \leq x \leq 90$	int
x-centroid	x	coordinate	longitude in WGS84	$x \in \mathbb{R} $ $12.243756 \leq x \leq$ 12.529203	decimal

Parameter Overview

Name	Short	Type	Description	Dimension	Format
y-centroid	y	coordinate	latitude in WGS84	$y \in \mathbb{R} $ $51.243821436824 \leq$ $y \leq$ 51.4273521843692	decimal
Product (PV)					
initial product awareness	awa_{init}^{cag}	distribution		$\mathbb{R}_{\geq 0}$	int
	Characteristic		Characteristic description		
	BUM		dirac distribution with $\delta = 1$		
	EPE		dirac distribution with $\delta = 1$		
	HED		dirac distribution with $\delta = 1$		
	KET		dirac distribution with $\delta = 1$		
	LIB		dirac distribution with $\delta = 1$		
	PER		dirac distribution with $\delta = 1$		
	PRA		dirac distribution with $\delta = 1$		
	PRE		dirac distribution with $\delta = 1$		
	SOK		dirac distribution with $\delta = 1$		
	TRA		dirac distribution with $\delta = 1$		
initial product interest	int_{init}^{cag}	distribution		$\mathbb{R}_{\geq 0}$	int
	Characteristic		Characteristic description		
	BUM		dirac distribution with $\delta = 0$		
	EPE		dirac distribution with $\delta = 0$		
	HED		dirac distribution with $\delta = 0$		
	KET		dirac distribution with $\delta = 0$		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	LIB		dirac distribution with $\delta = 0$		
	PER		dirac distribution with $\delta = 0$		
	PRA		dirac distribution with $\delta = 0$		
	PRE		dirac distribution with $\delta = 0$		
	SOK		dirac distribution with $\delta = 0$		
	TRA		dirac distribution with $\delta = 0$		
awareness	<i>awa</i>	categorical	Awareness is always 1.	$\{1\}$	int
	Characteristic		Characteristic description		
	0		not aware		
	1		aware		
interest level	<i>int</i>	number		$\mathbb{N}_{\geq 0}$	int
interest threshold	<i>IT</i>	number		$\mathbb{N}_{\geq 0}$	int
adoption threshold	<i>AT</i>	number		$[0, 1] \subset \mathbb{R}_{\geq 0}$	decimal
financial threshold	<i>FT</i>	number		$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		38827.44		
number initial product adopter	<i>adopt_{init}</i>	number	Based on real data from the year before the start of the simulation.	$\mathbb{N}_{\geq 0}$	int
price increase factor	<i>p_{esc}</i>	number	average annual increase in electricity prices	$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.031328639		
degradation	<i>D</i>	number	average annual degradation of PV systems	$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.005		
self-consumption ratio	<i>SC</i>	number	average self-consumption ratio	$[0, 1] \subset \mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.3		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
investment horizon	t_{FIT}	number	calculation horizon, based on 20 years guaranteed feed-in tariff	$\mathbb{N}_{\geq 0}$ 20	decimal
Reference Value:			20		
solar irradiation	$solar(roof_i)$	number series	average annual global radiation in kWh per 6m ² area with inclination N at south orientation	$\mathbb{R}_{\geq 0}$	decimal
adjustment factor	$adj(roof_o)$	number series	factor for reduction of the amount of radiation by deviation from south ori- entation	$\mathbb{R}_{\geq 0}$	decimal
investment cost	p_{invest}	number series	price per kWpeak in €	$\mathbb{R}_{\geq 0}$	decimal
electricity price	p_{elec}	number series	electricity price per kWh in €	$\mathbb{R}_{\geq 0}$	decimal
feed-in tariff	FIT	number series	feed-in tariff for small plant in €	$\mathbb{R}_{\geq 0}$	decimal
interest rate	r_{int}	number series	interest rate for risk-free savings de- posits in Germany	$\mathbb{R}_{\geq 0}$	decimal
module efficiency	η	number series	average efficiency under laboratory conditions (laboratory efficiency)	$\mathbb{R}_{\geq 0}$	decimal
performance ratio	pr	number series	factor for reduction of efficiency due to shading, pollution, maintenance, con- duction, etc. (real efficiency)	$\mathbb{R}_{\geq 0}$	decimal
Process model for product (PV)					
adopter influence	ai	number		$\mathbb{N}_{\geq 0}$	
Reference Value:			3		

Parameter Overview

Name	Short	Type	Description	Dimension	Format
interested agent influence	iai	number		$\mathbb{N}_{\geq 0}$	
	Reference Value:		2		
aware agent influence	aai	number		$\mathbb{N}_{\geq 0}$	
	Reference Value:		1		
weight finance	w_f	number		\mathbb{R}	
	Reference Value:		0.5927		
weight social pressure	w_s	number		\mathbb{R}	
	Reference Value:		0		
weight local pressure	w_l	number		\mathbb{R}	
	Reference Value:		0.1589		
weight novelty seeking	w_{ns}	number		\mathbb{R}	
	Reference Value:		0.348		
weight environmental concern	w_{ec}	number		\mathbb{R}	
	Reference Value:		-0.0996		
distance filter		filter function	Determines the agents that are located in the area around an agent.	$\mathbb{R}_{\geq 0}$	
	Reference Value:		max_2 (maximum distance of 2)		
Discrete time model					

Parameter Overview

Name	Short	Type	Description	Dimension	Format
initial simulation year	t_0	year		$[2008, 2019] \cap \mathbb{N}$	int
	Reference Value:		2008		
final simulation year	t_n	year		$[t_0, 2019] \cap \mathbb{N}$	int
	Reference Value:		2019		
time delta		number	specifies, together with time unit , the amount of time that is added in each discrete step	$\mathbb{N}_{\geq 0}$	int
	Reference Value:		1		
time unit		categorical			
	Characteristic		Characteristic description		
	second				
	minute				
	hour				
	day				
	week				
	month				
	year				
	Reference Value:		week		
Relative agreement and uncertainty					
speed of convergence	soc	number		$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.1		
attitude gap threshold	AGT	number		$\mathbb{R}_{\geq 0}$	decimal

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	Reference Value:		0.1		
chance neutral	c_{neut}	number		$\mathbb{R}_{\geq 0} \wedge (c_{neut} + c_{con} + c_{div} = 1)$	decimal
	Reference Value:		0.5		
chance convergence	c_{con}	number		$\mathbb{R}_{\geq 0} \wedge (c_{neut} + c_{con} + c_{div} = 1)$	decimal
	Reference Value:		0.25		
chance divergence	c_{div}	number		$\mathbb{R}_{\geq 0} \wedge (c_{neut} + c_{con} + c_{div} = 1)$	decimal
	Reference Value:		0.25		
extremist rate	r_{ext}	number		$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.125		
moderate uncertainty	unc_{mod}	number		$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.4		
extremist uncertainty	unc_{ext}	number		$\mathbb{R}_{\geq 0}$	decimal
	Reference Value:		0.21		
Growth function environmental concern (linear)					
y-intercept	ec_n	number		\mathbb{R}	decimal
	Reference Value:		-11.466		
slope	ec_m	number		\mathbb{R}	decimal
	Reference Value:		0.006		
Spatial model					
distance metric		categorical			metric

Parameter Overview

Name	Short	Type	Description	Dimension	Format
	Characteristic		Characteristic description		
	haversine_m		haversine metric with distance in meter		
	haversine_km		haversine metric with distance in kilometer		
	Reference Value:		haversine_km		

Table 50: Consumer Agent Group Affinities Matrix

	KET	LIB	PER	EPE	PRA	SOK	BUM	TRA	PRE	HED
KET	0.53	0.094	0	0	0	0.094	0.094	0.094	0	0
LIB	0.1175	0.53	0.1175	0	0	0.1175	0	0	0	0
PER	0	0.094	0.53	0.094	0.094	0.094	0	0	0	0
EPE	0	0	0.1175	0.53	0.1175	0	0	0	0	0
PRA	0	0	0.0783333	0.0783333	0.53	0.0783333	0.0783333	0	0	0
SOK	0.0783333	0.0783333	0.0783333	0	0.0783333	0.53	0.0783333	0	0	0
BUM	0.0671429	0	0	0	0.0671429	0.0671429	0.53	0.0671429	0.0671429	0
TRA	0.1175	0	0	0	0	0	0.1175	0.53	0.1175	0
PRE	0	0	0	0	0	0	0.1175	0.1175	0.53	0
HED	0	0	0	0.094	0.094	0	0.094	0	0.094	0