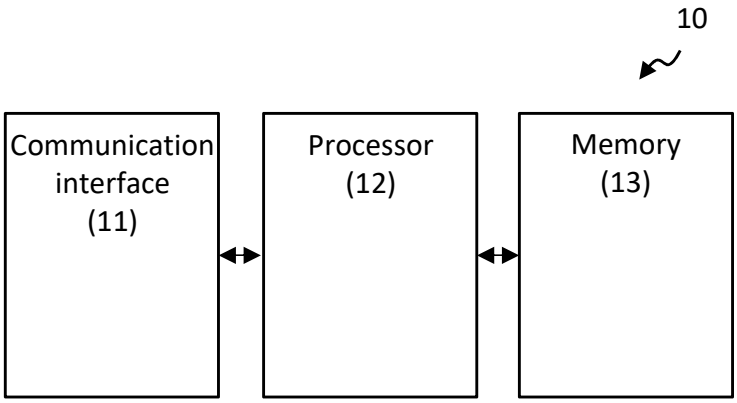


FIG. 1

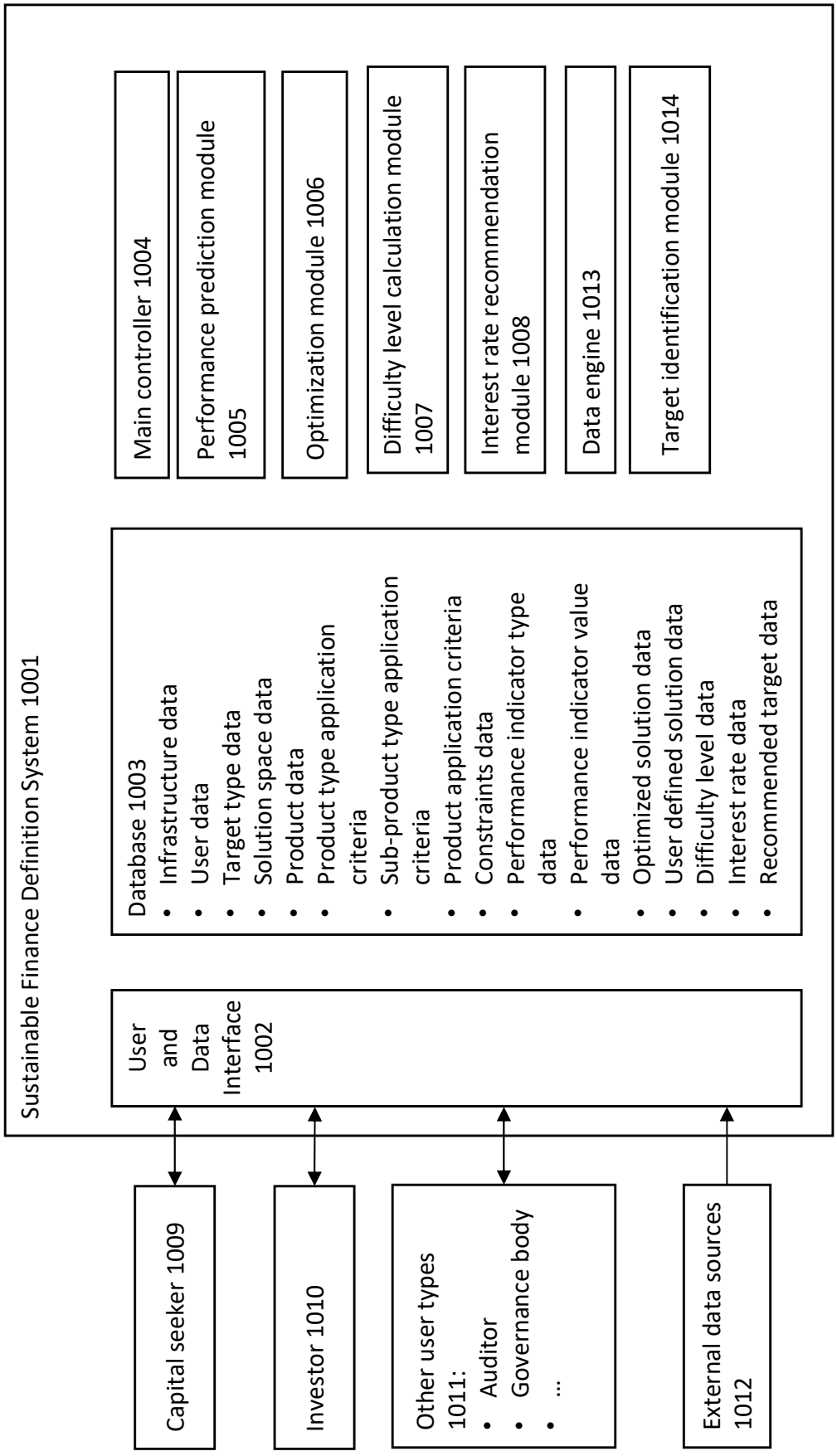

Sustainable Finance Definition System 1001
User and Data Interface 1002
Database 1003
• Infrastructure data
• User data
• Target type data
• Solution space data
• Product data
• Product type application criteria
• Sub-product type application criteria
• Product application criteria
• Constraints data
• Performance indicator type data
• Performance indicator value data
• Optimized solution data
• User defined solution data
• Difficulty level data
• Interest rate data
• Recommended target data
Main controller 1004
Performance prediction module 1005
Optimization module 1006
Difficulty level calculation module 1007
Interest rate recommendation module 1008
Data engine 1013
Target identification module 1014
Capital seeker 1009
Investor 1010
Other user types 1011:
• Auditor
• Governance body
• ...
External data sources 1012

FIG. 2

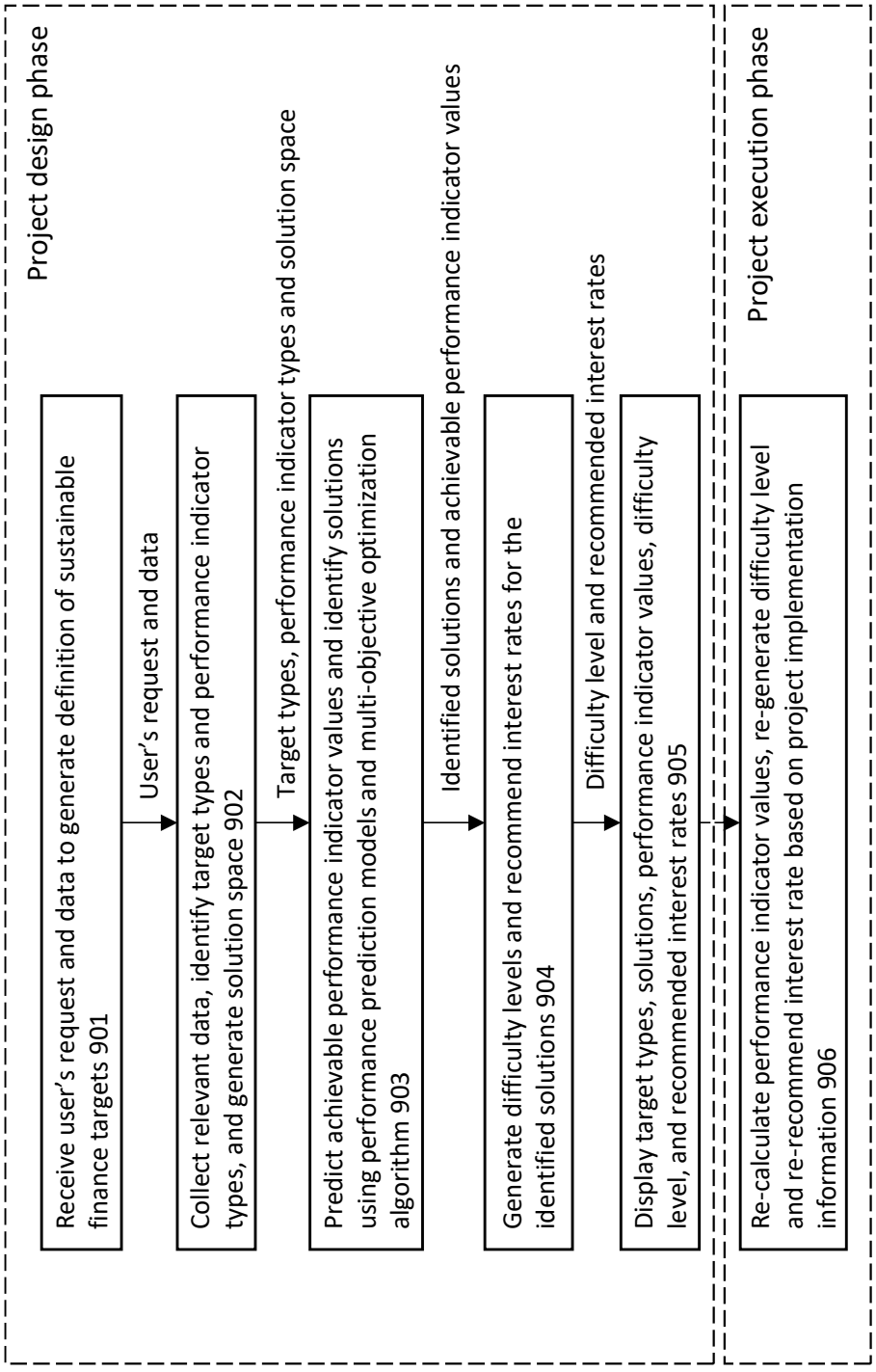

Project design phase
Receive user's request and data to generate definition of sustainable finance targets 901
User's request and data
Collect relevant data, identify target types and performance indicator types, and generate solution space 902
Target types, performance indicator types and solution space
Predict achievable performance indicator values and identify solutions using performance prediction models and multi-objective optimization algorithm 903
Identified solutions and achievable performance indicator values
Generate difficulty levels and recommend interest rates for the identified solutions 904
Difficulty level and recommended interest rates
Display target types, solutions, performance indicator values, difficulty level, and recommended interest rates 905
Project execution phase
Re-calculate performance indicator values, re-generate difficulty level and re-recommend interest rate based on project implementation information 906

FIG. 3

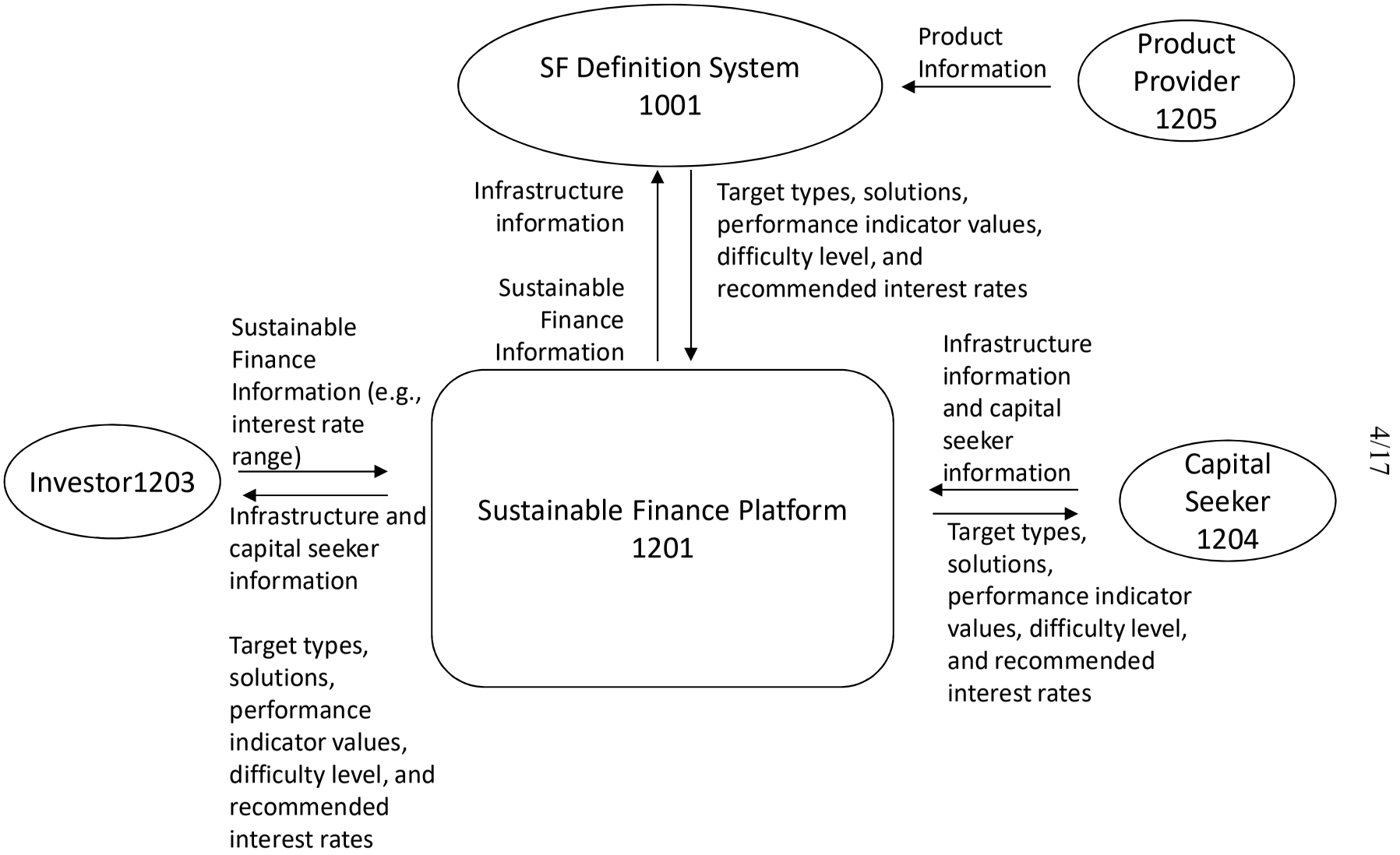

SF Definition System
1001
Product
Information
Product
Provider
1205
Infrastructure
information
Sustainable
Finance
Information
Target types, solutions,
performance indicator values,
difficulty level, and
recommended interest rates
Sustainable
Finance
Information (e.g.,
interest rate
range)
Infrastructure and
capital seeker
information
Investor1203
Sustainable Finance Platform
1201
Infrastructure
information
and capital
seeker
information
Target types,
solutions,
performance indicator
values, difficulty level,
and recommended
interest rates
Capital
Seeker
1204

FIG. 4

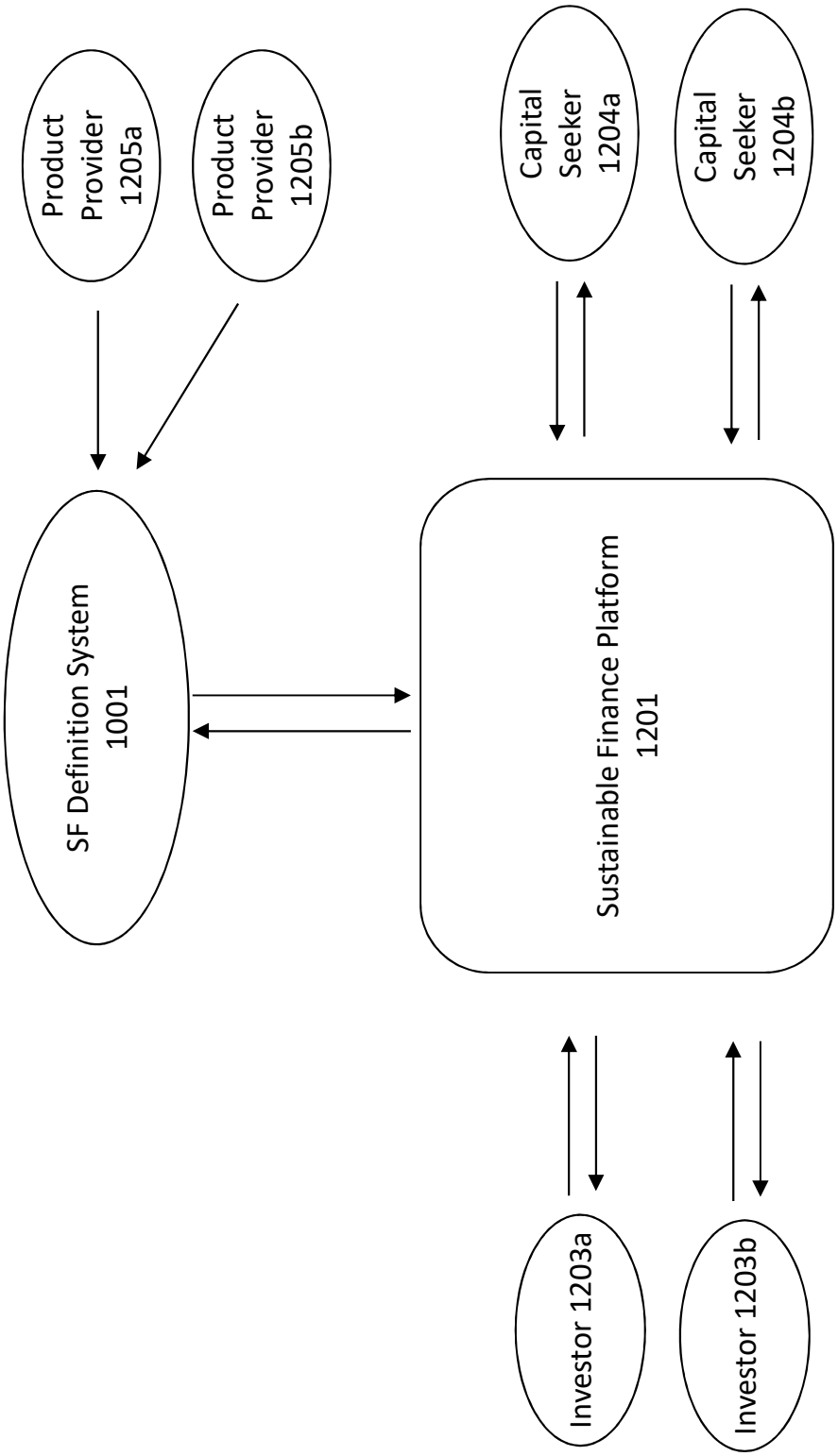

Product Provider 1205a
Product Provider 1205b
Capital Seeker 1204a
Capital Seeker 1204b
SF Definition System 1001
Sustainable Finance Platform 1201
Investor 1203a
Investor 1203b

FIG. 5

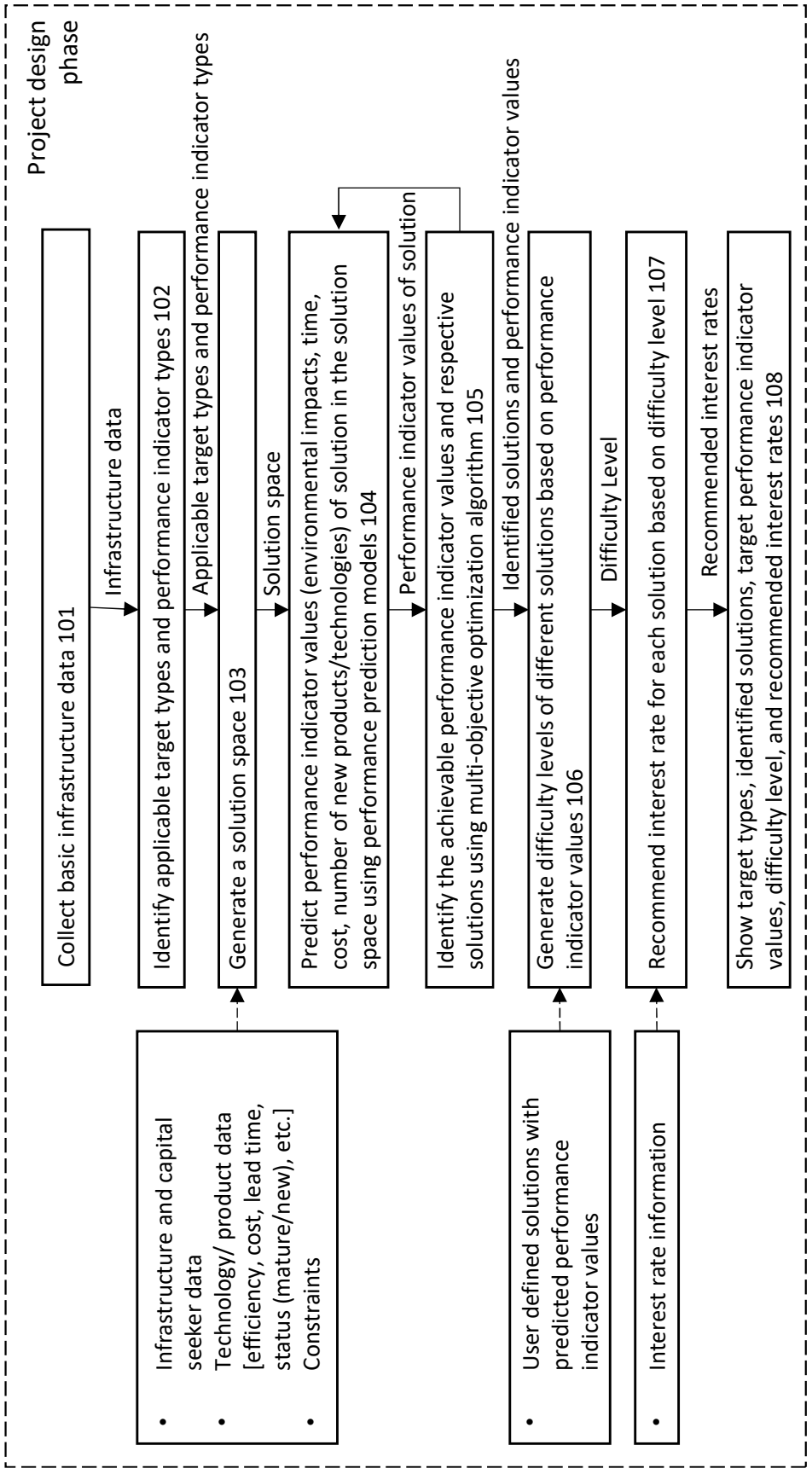

Project design phase
Collect basic infrastructure data 101
Infrastructure data
Identify applicable target types and performance indicator types 102
Applicable target types and performance indicator types
Generate a solution space 103
Solution space
Predict performance indicator values (environmental impacts, time, cost, number of new products/technologies) of solution in the solution space using performance prediction models 104
Performance indicator values of solution
Identify the achievable performance indicator values and respective solutions using multi-objective optimization algorithm 105
Identified solutions and performance indicator values
Generate difficulty levels of different solutions based on performance indicator values 106
Difficulty Level
Recommend interest rate for each solution based on difficulty level 107
Recommended interest rates
Show target types, identified solutions, target performance indicator values, difficulty level, and recommended interest rates 108
• Infrastructure and capital seeker data
• Technology/ product data [efficiency, cost, lead time, status (mature/new), etc.]
• Constraints
• User defined solutions with predicted performance indicator values
• Interest rate information

FIG. 6

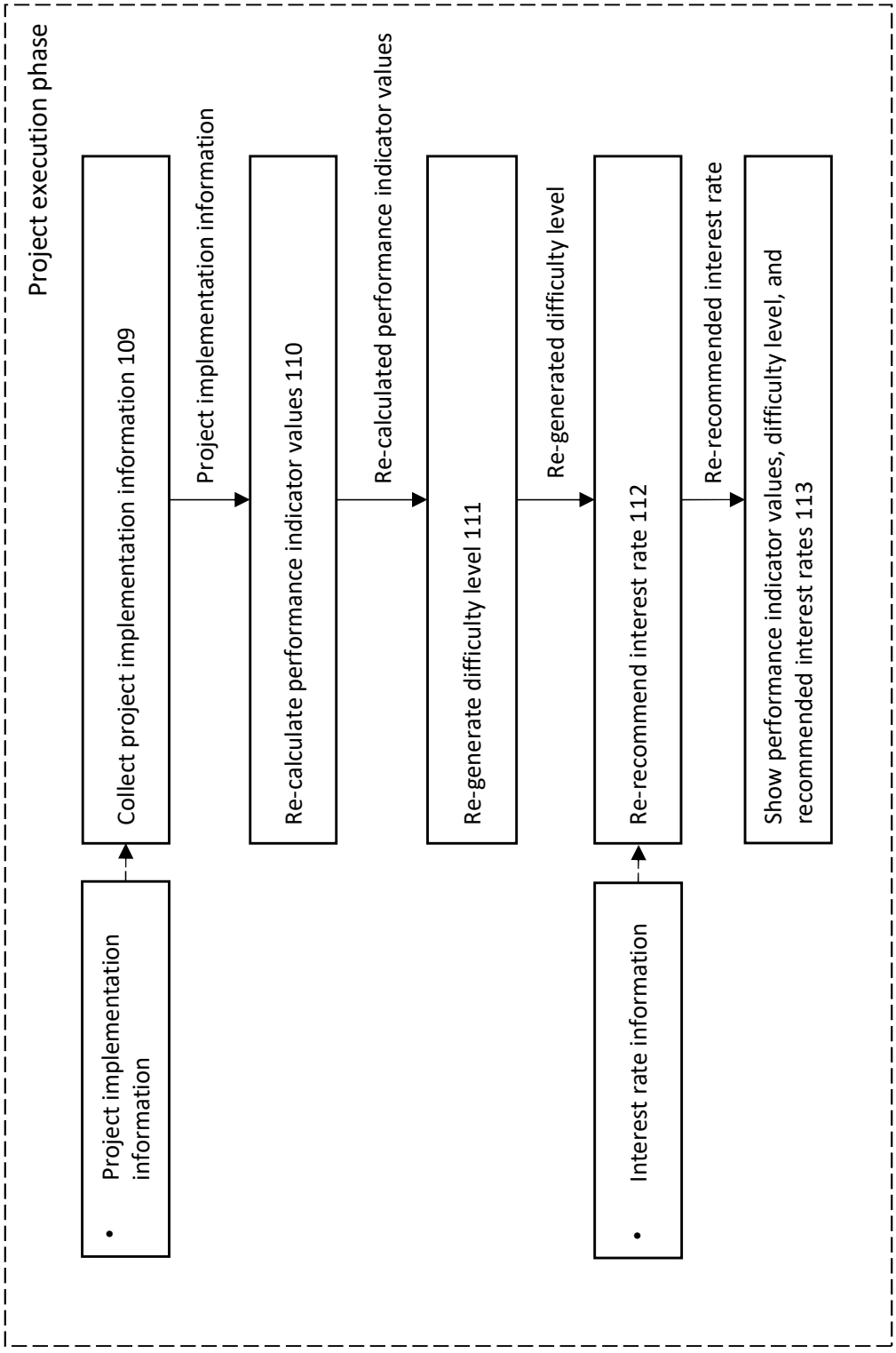

Project execution phase
Collect project implementation information 109
Project implementation information
Re-calculate performance indicator values 110
Re-calculated performance indicator values
Re-generate difficulty level 111
Re-generated difficulty level
Re-recommend interest rate 112
Re-recommended interest rate
Show performance indicator values, difficulty level, and recommended interest rates 113
• Project implementation information
• Interest rate information

FIG. 7

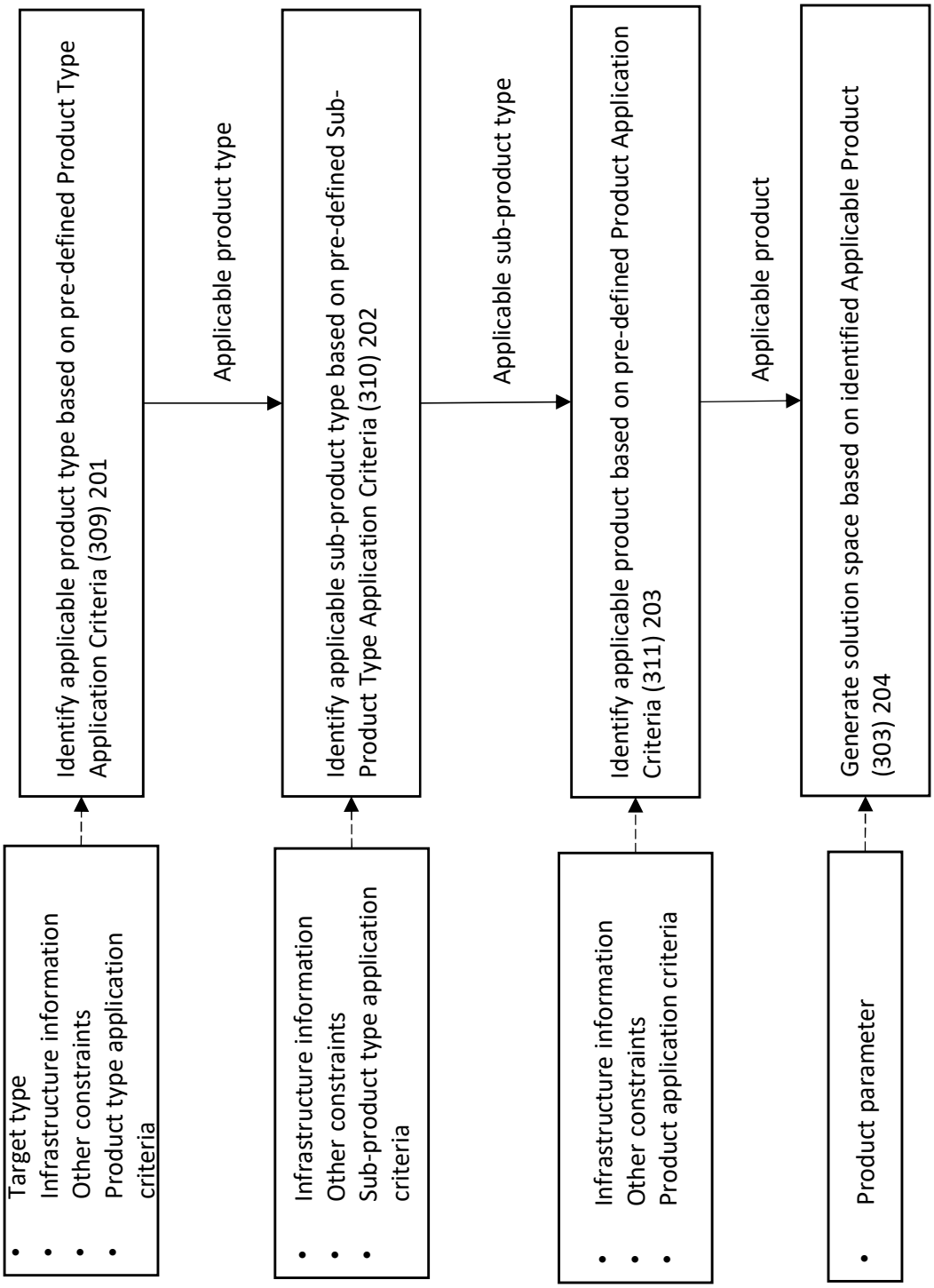

Identify applicable product type based on pre-defined Product Type Application Criteria (309) 201
Target type
Infrastructure information
Other constraints
Product type application criteria
Applicable product type
Identify applicable sub-product type based on pre-defined Sub-Product Type Application Criteria (310) 202
Infrastructure information
Other constraints
Sub-product type application criteria
Applicable sub-product type
Identify applicable product based on pre-defined Product Application Criteria (311) 203
Infrastructure information
Other constraints
Product application criteria
Applicable product
Generate solution space based on identified Applicable Product (303) 204
Product parameter

FIG. 8

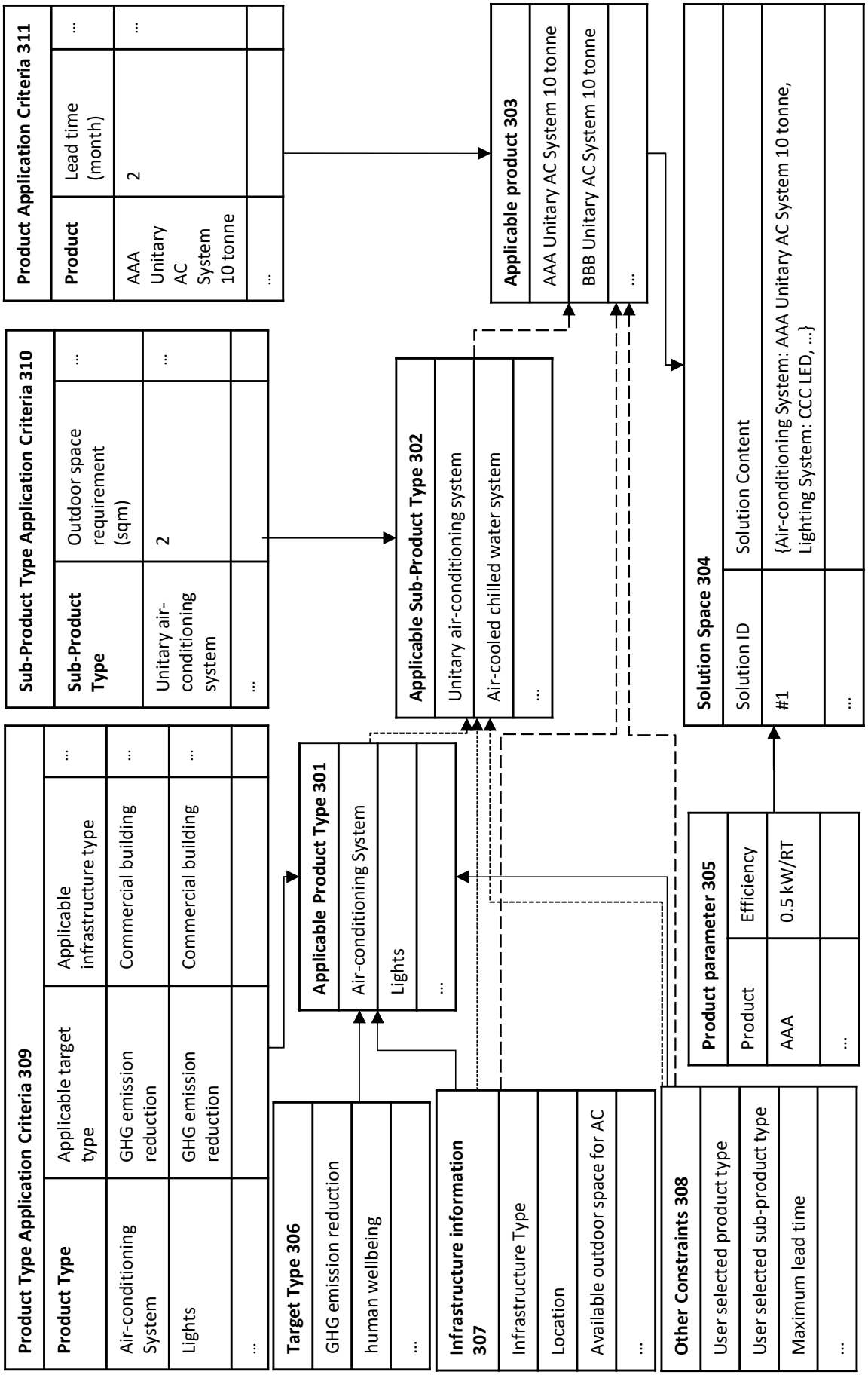

Product Type Application Criteria 309
Product Type
Applicable target type
Applicable infrastructure type
Air-conditioning System
GHG emission reduction
Commercial building
Lights
GHG emission reduction
Commercial building
Sub-Product Type Application Criteria 310
Sub-Product Type
Outdoor space requirement (sqm)
Unitary air-conditioning system
2
Product Application Criteria 311
Product
Lead time (month)
AAA Unitary AC System 10 tonne
2
Target Type 306
GHG emission reduction
human wellbeing
Applicable Product Type 301
Air-conditioning System
Lights
Applicable Sub-Product Type 302
Unitary air-conditioning system
Air-cooled chilled water system
Applicable product 303
AAA Unitary AC System 10 tonne
BBB Unitary AC System 10 tonne
Infrastructure information 307
Infrastructure Type
Location
Available outdoor space for AC
Other Constraints 308
User selected product type
User selected sub-product type
Maximum lead time
Product parameter 305
Product
Efficiency
AAA
0.5 kW/RT
Solution Space 304
Solution ID
Solution Content
#1
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: CCC LED, ...}

FIG. 9

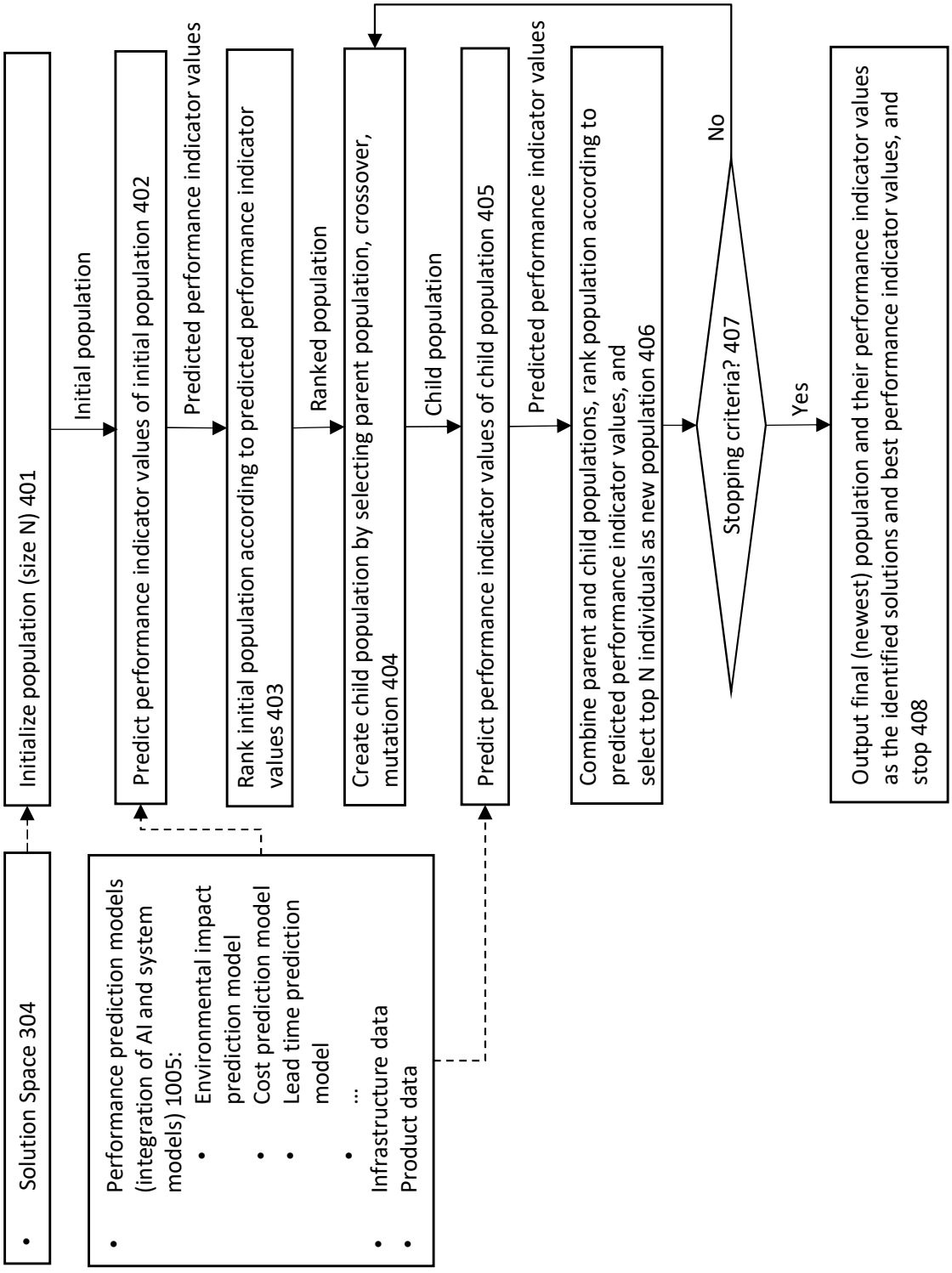

Solution Space 304
Initialize population (size N) 401
Initial population
Predict performance indicator values of initial population 402
Predicted performance indicator values
Rank initial population according to predicted performance indicator values 403
Ranked population
Create child population by selecting parent population, crossover, mutation 404
Child population
Predict performance indicator values of child population 405
Predicted performance indicator values
Combine parent and child populations, rank population according to predicted performance indicator values, and select top N individuals as new population 406
Stopping criteria? 407
No
Yes
Output final (newest) population and their performance indicator values as the identified solutions and best performance indicator values, and stop 408
Performance prediction models (integration of AI and system models) 1005:
Environmental impact prediction model
Cost prediction model
Lead time prediction model
...
Infrastructure data
Product data

FIG. 10

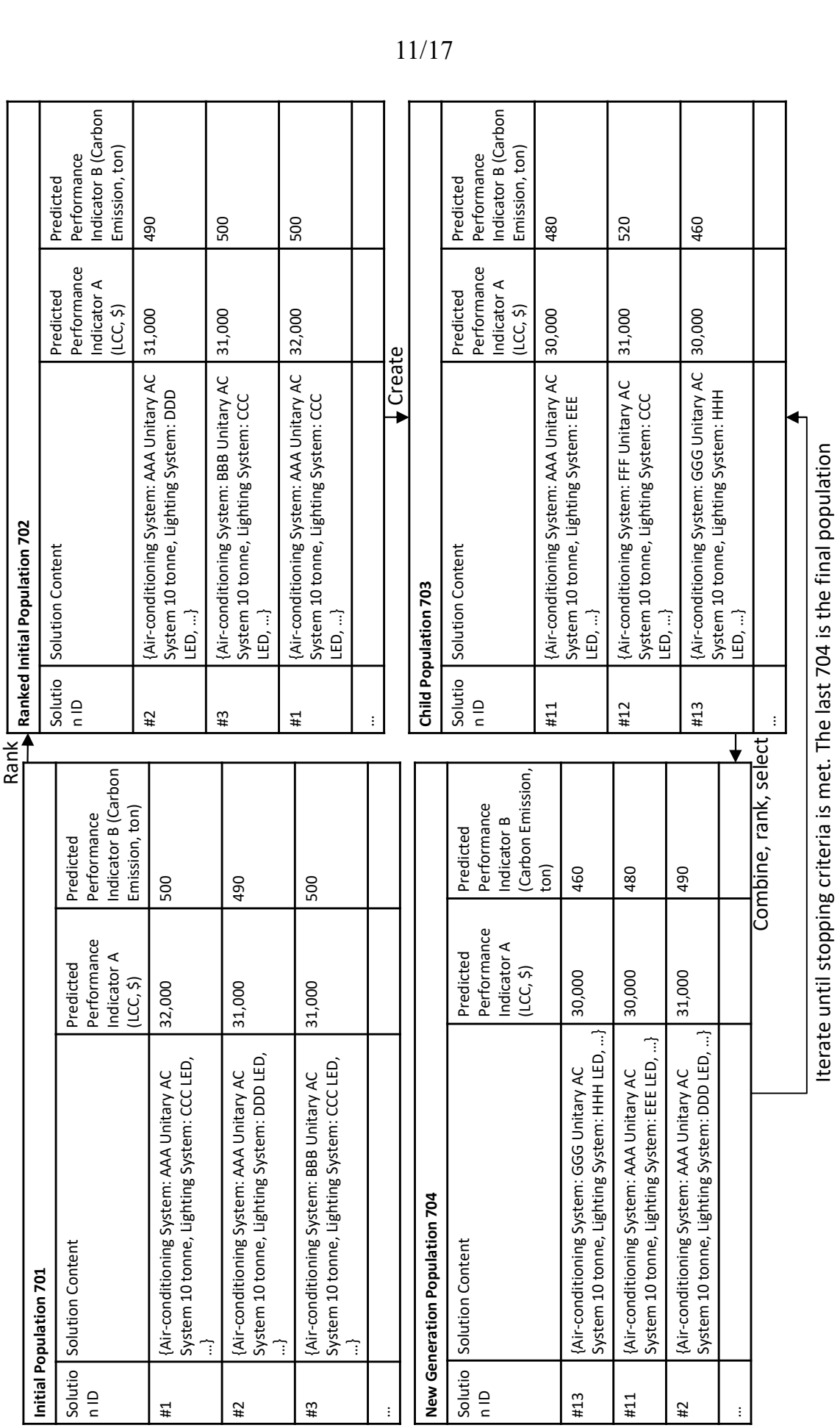

Rank
Initial Population 701
Solution ID
Solution Content
Predicted Performance Indicator A (LCC, $)
Predicted Performance Indicator B (Carbon Emission, ton)
#1
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: CCC LED, ...}
32,000
500
#2
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: DDD LED, ...}
31,000
490
#3
{Air-conditioning System: BBB Unitary AC System 10 tonne, Lighting System: CCC LED, ...}
31,000
500
...
Ranked Initial Population 702
Solution ID
Solution Content
Predicted Performance Indicator A (LCC, $)
Predicted Performance Indicator B (Carbon Emission, ton)
#2
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: DDD LED, ...}
31,000
490
#3
{Air-conditioning System: BBB Unitary AC System 10 tonne, Lighting System: CCC LED, ...}
31,000
500
#1
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: CCC LED, ...}
32,000
500
...
Create
Child Population 703
Solution ID
Solution Content
Predicted Performance Indicator A (LCC, $)
Predicted Performance Indicator B (Carbon Emission, ton)
#11
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: EEE LED, ...}
30,000
480
#12
{Air-conditioning System: FFF Unitary AC System 10 tonne, Lighting System: CCC LED, ...}
31,000
520
#13
{Air-conditioning System: GGG Unitary AC System 10 tonne, Lighting System: HHH LED, ...}
30,000
460
...
Combine, rank, select
New Generation Population 704
Solution ID
Solution Content
Predicted Performance Indicator A (LCC, $)
Predicted Performance Indicator B (Carbon Emission, ton)
#13
{Air-conditioning System: GGG Unitary AC System 10 tonne, Lighting System: HHH LED, ...}
30,000
460
#11
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: EEE LED, ...}
30,000
480
#2
{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: DDD LED, ...}
31,000
490
...
Iterate until stopping criteria is met. The last 704 is the final population

FIG. 11

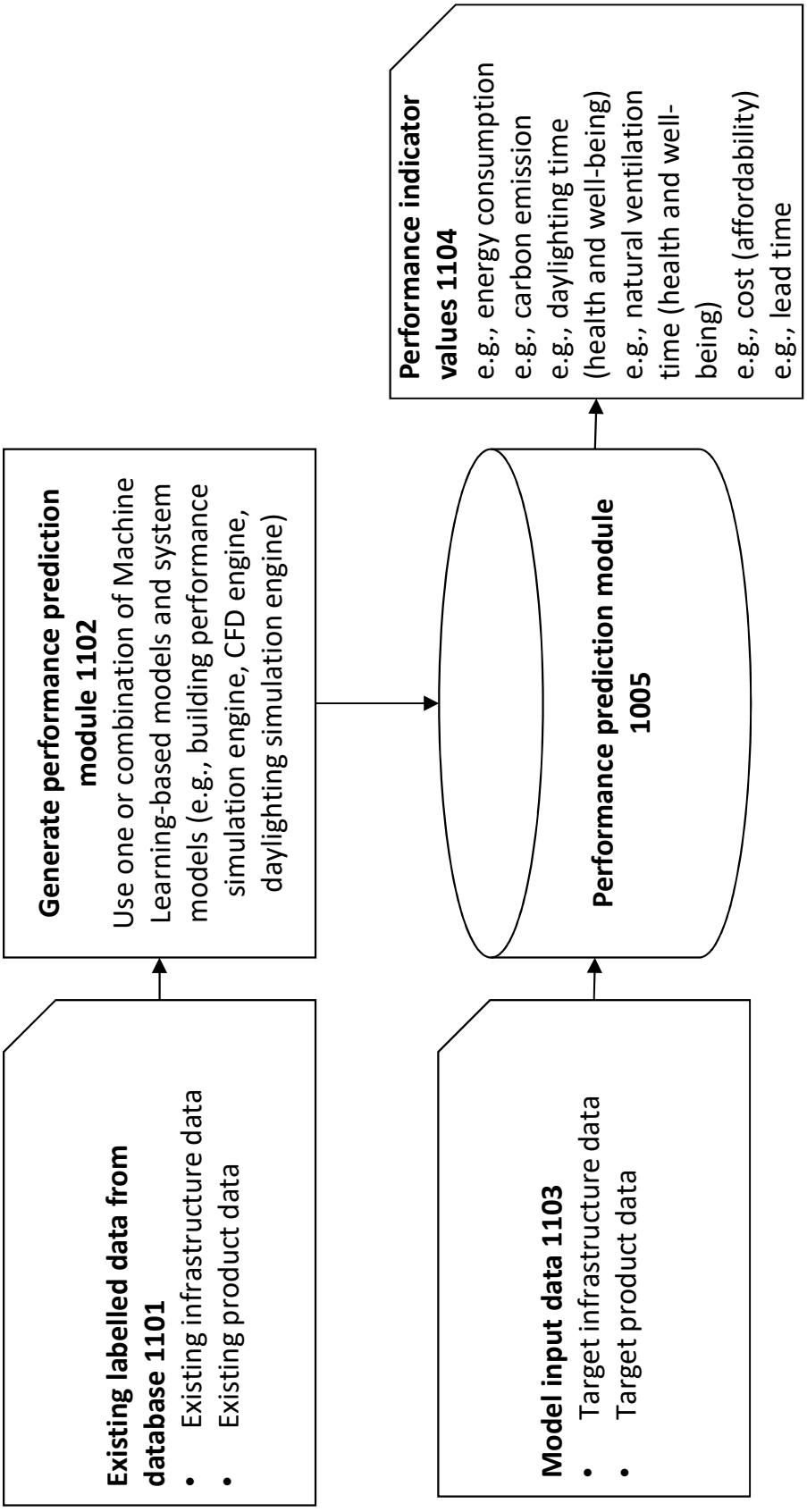

Existing labelled data from database 1101
• Existing infrastructure data
• Existing product data
Generate performance prediction module 1102
Use one or combination of Machine Learning-based models and system models (e.g., building performance simulation engine, CFD engine, daylighting simulation engine)
Model input data 1103
• Target infrastructure data
• Target product data
Performance prediction module 1005
Performance indicator values 1104
e.g., energy consumption
e.g., carbon emission
e.g., daylighting time
(health and well-being)
e.g., natural ventilation time (health and well-being)
e.g., cost (affordability)
e.g., lead time

FIG. 12

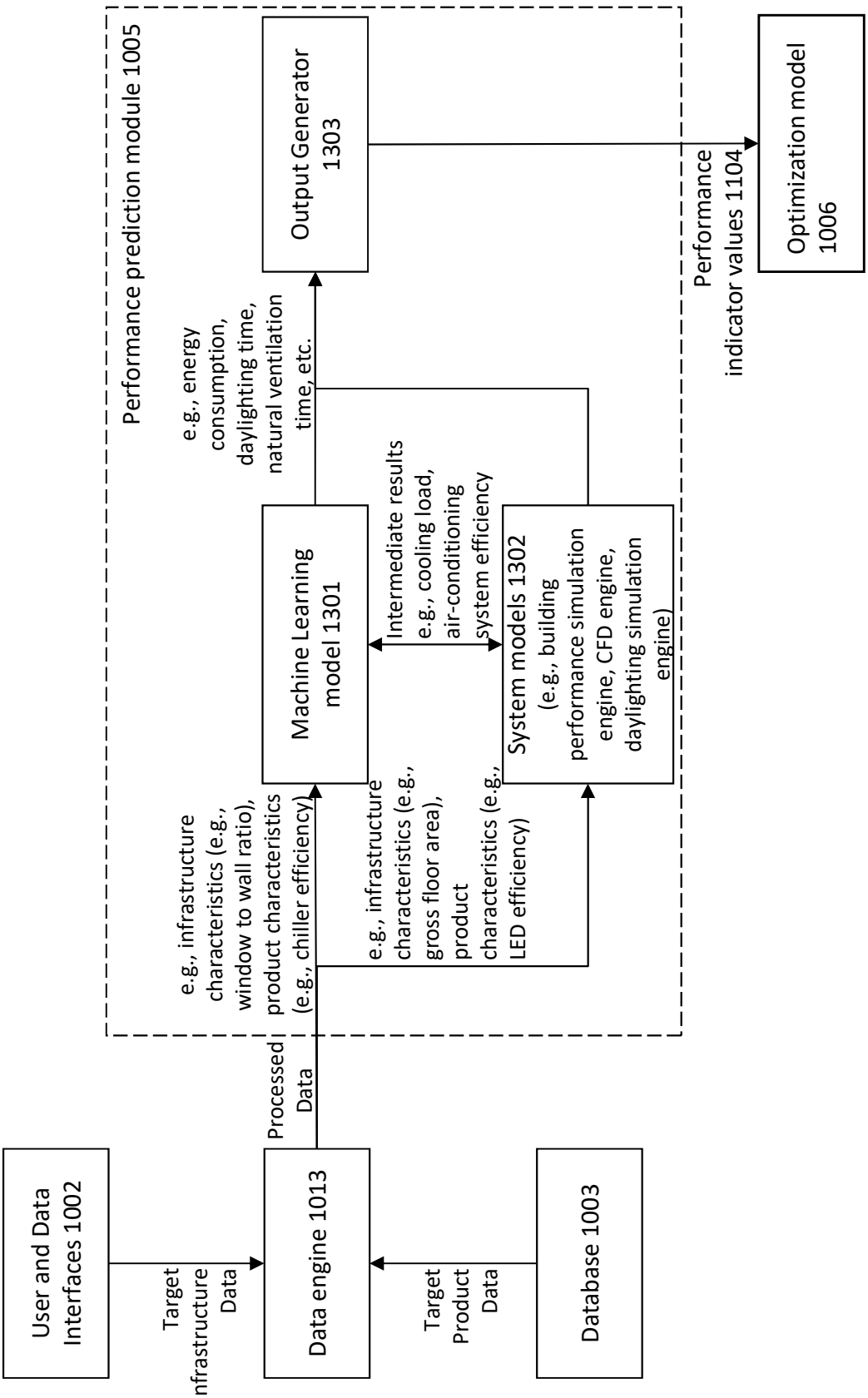

User and Data Interfaces 1002
Target Infrastructure Data
Data engine 1013
Target Product Data
Database 1003
Processed Data
Performance prediction module 1005
e.g., infrastructure characteristics (e.g., window to wall ratio), product characteristics (e.g., chiller efficiency)
Machine Learning model 1301
e.g., infrastructure characteristics (e.g., gross floor area), product characteristics (e.g., LED efficiency)
Intermediate results e.g., cooling load, air-conditioning system efficiency
System models 1302 (e.g., building performance simulation engine, CFD engine, daylighting simulation engine)
e.g., energy consumption, daylighting time, natural ventilation time, etc.
Output Generator 1303
Performance indicator values 1104
Optimization model 1006

FIG. 13

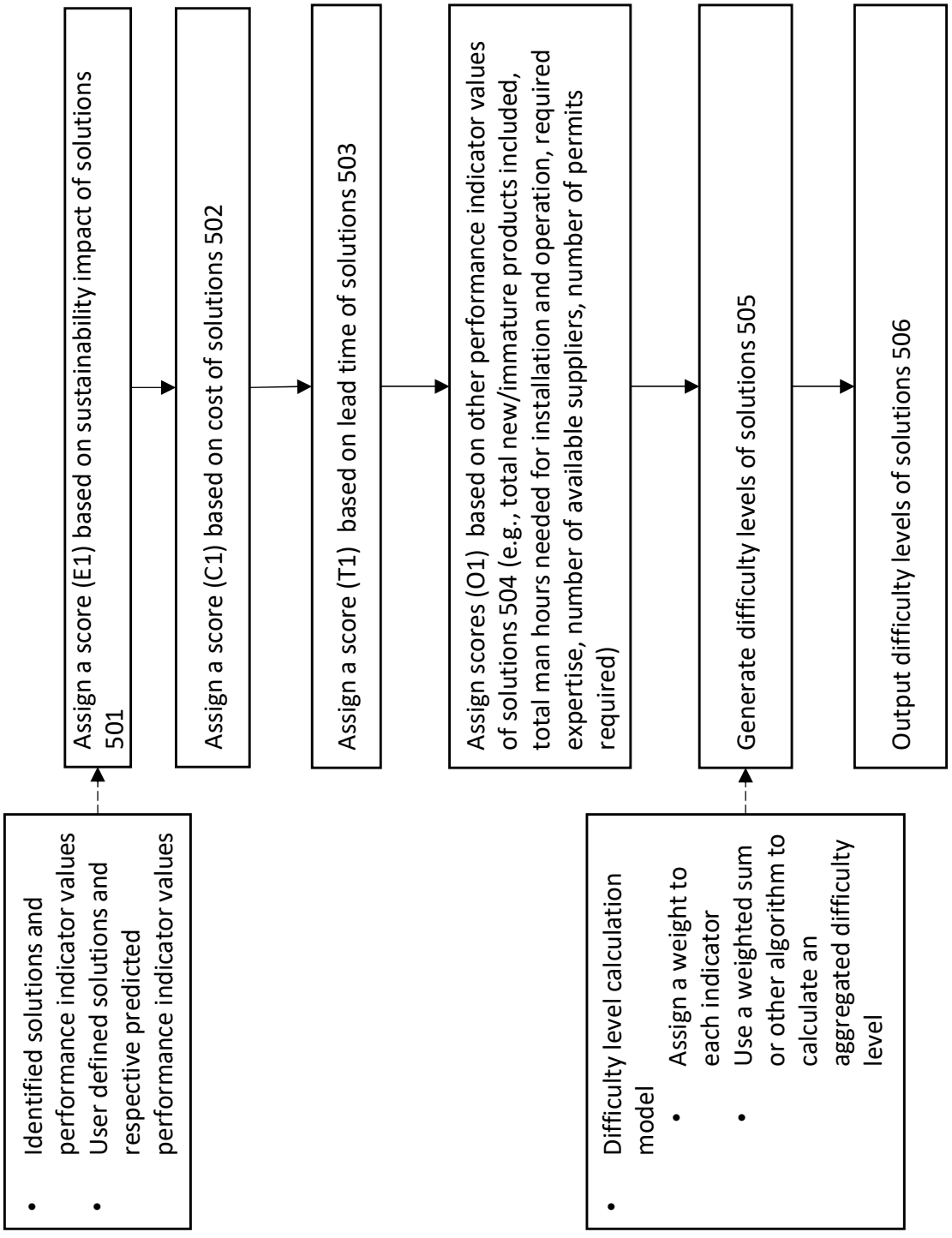
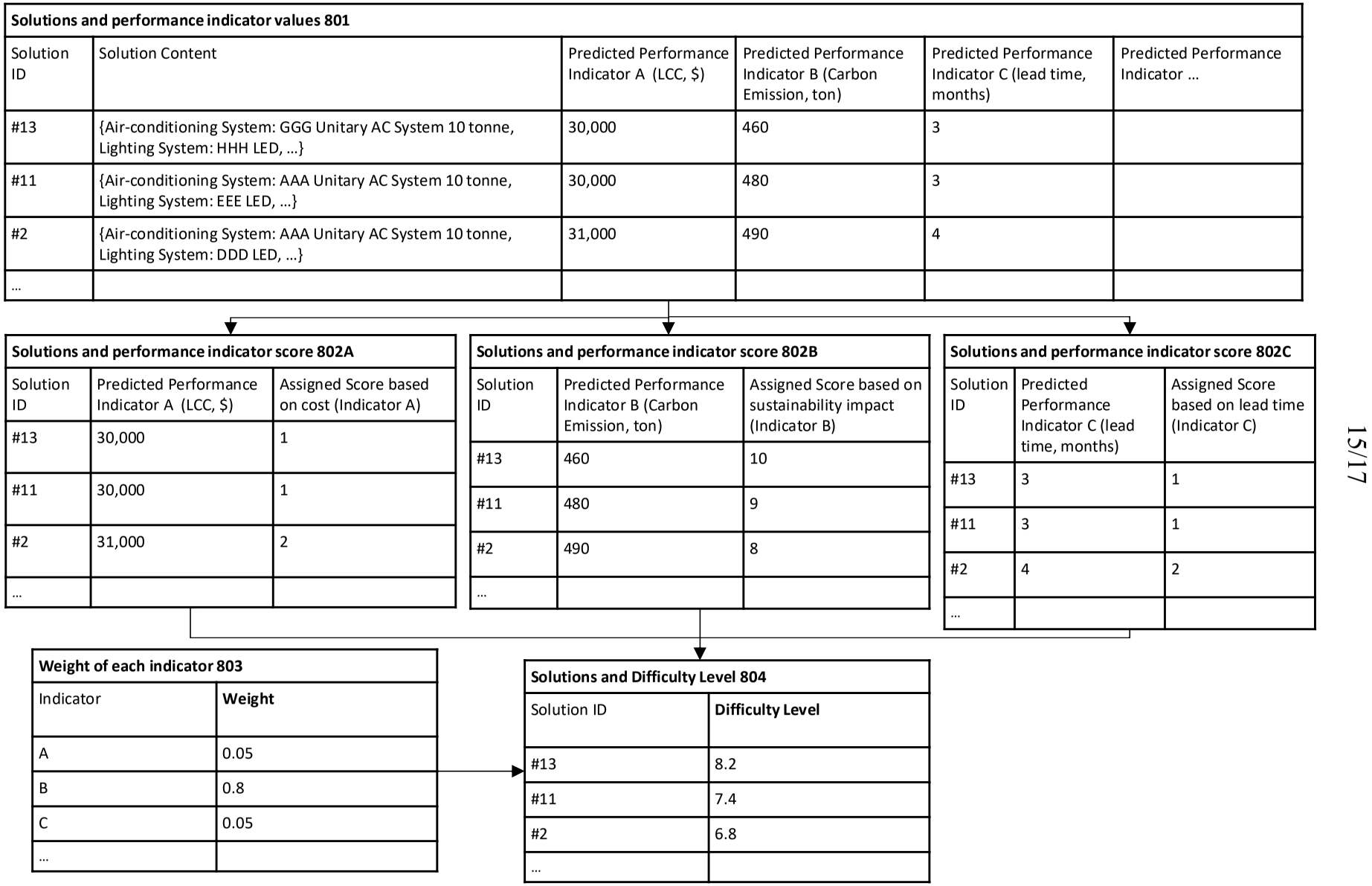

Identified solutions and performance indicator values
User defined solutions and respective predicted performance indicator values
Assign a score (E1) based on sustainability impact of solutions 501
Assign a score (C1) based on cost of solutions 502
Assign a score (T1) based on lead time of solutions 503
Assign scores (O1) based on other performance indicator values of solutions 504 (e.g., total new/immature products included, total man hours needed for installation and operation, required expertise, number of available suppliers, number of permits required)
Difficulty level calculation model
Assign a weight to each indicator
Use a weighted sum or other algorithm to calculate an aggregated difficulty level
Generate difficulty levels of solutions 505
Output difficulty levels of solutions 506

FIG. 14



Solutions and performance indicator values 801

Solution ID	Solution Content	Predicted Performance Indicator A (LCC, $)	Predicted Performance Indicator B (Carbon Emission, ton)	Predicted Performance Indicator C (lead time, months)	Predicted Performance Indicator …
#13	{Air-conditioning System: GGG Unitary AC System 10 tonne, Lighting System: HHH LED, …}	30,000	460	3	
#11	{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: EEE LED, …}	30,000	480	3	
#2	{Air-conditioning System: AAA Unitary AC System 10 tonne, Lighting System: DDD LED, …}	31,000	490	4	
…					

Solutions and performance indicator score 802A

Solution ID	Predicted Performance Indicator A (LCC, $)	Assigned Score based on cost (Indicator A)
#13	30,000	1
#11	30,000	1
#2	31,000	2
…		

Solutions and performance indicator score 802B

Solution ID	Predicted Performance Indicator B (Carbon Emission, ton)	Assigned Score based on sustainability impact (Indicator B)
#13	460	10
#11	480	9
#2	490	8
…		

Solutions and performance indicator score 802C

Solution ID	Predicted Performance Indicator C (lead time, months)	Assigned Score based on lead time (Indicator C)
#13	3	1
#11	3	1
#2	4	2
…		

Weight of each indicator 803

Indicator	**Weight**
A	0.05
B	0.8
C	0.05
…	

Solutions and Difficulty Level 804

Solution ID	**Difficulty Level**
#13	8.2
#11	7.4
#2	6.8
…	

FIG. 15

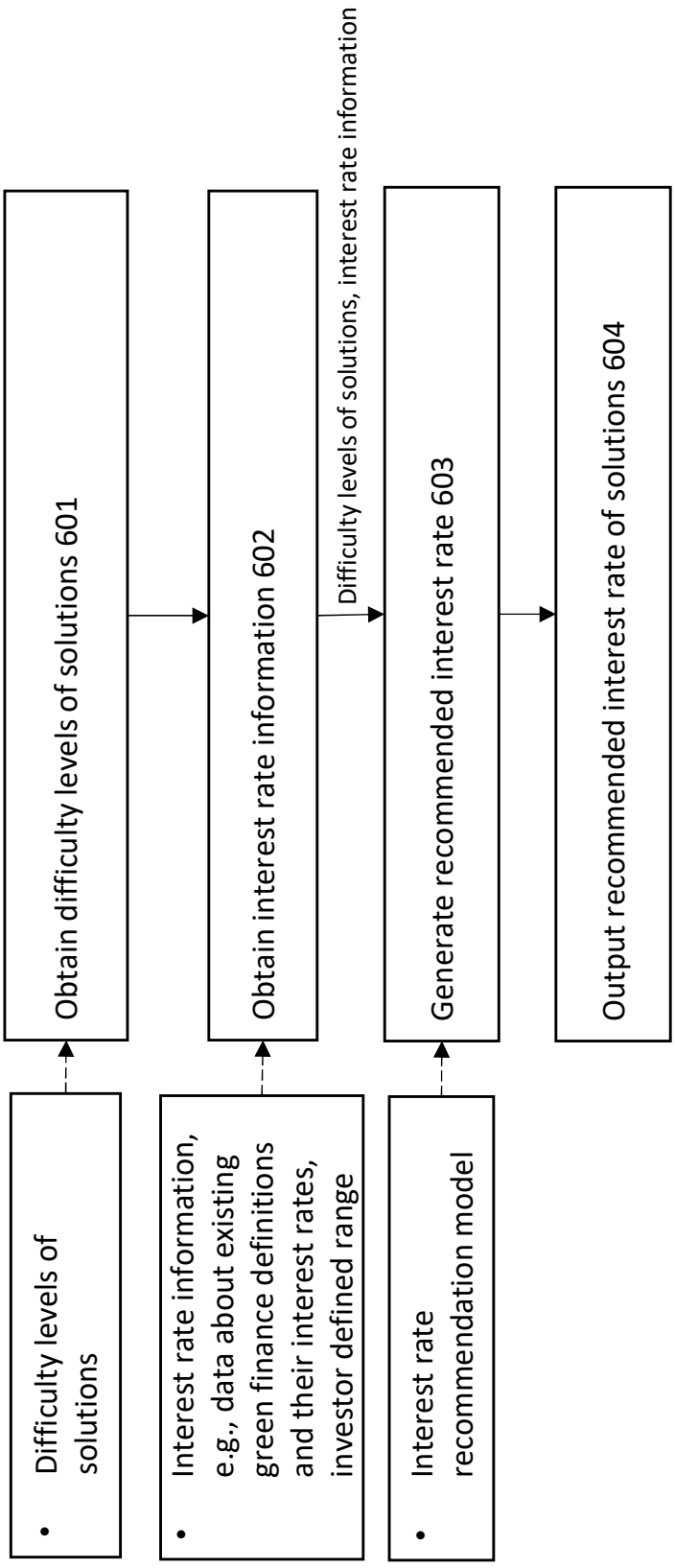

Obtain difficulty levels of solutions 601
Obtain interest rate information 602
Difficulty levels of solutions, interest rate information
Generate recommended interest rate 603
Output recommended interest rate of solutions 604
• Difficulty levels of solutions
• Interest rate information, e.g., data about existing green finance definitions and their interest rates, investor defined range
• Interest rate recommendation model

FIG. 16

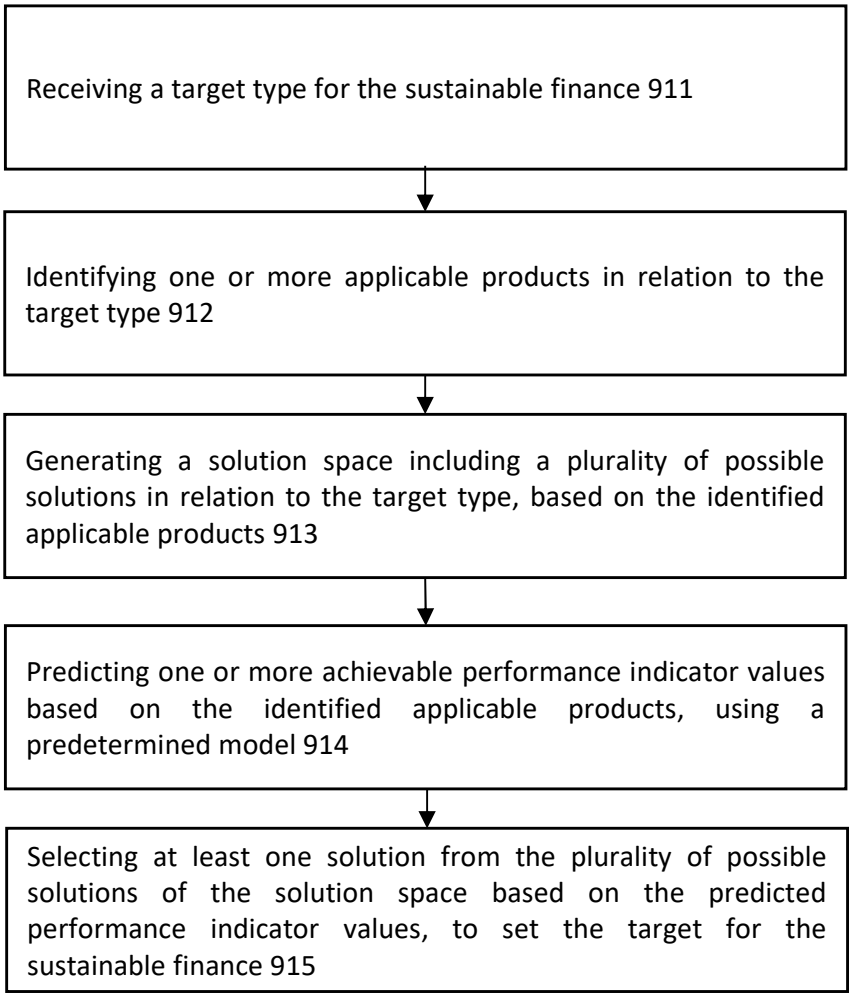

Receiving a target type for the sustainable finance 911
Identifying one or more applicable products in relation to the target type 912
Generating a solution space including a plurality of possible solutions in relation to the target type, based on the identified applicable products 913
Predicting one or more achievable performance indicator values based on the identified applicable products, using a predetermined model 914
Selecting at least one solution from the plurality of possible solutions of the solution space based on the predicted performance indicator values, to set the target for the sustainable finance 915

FIG. 17