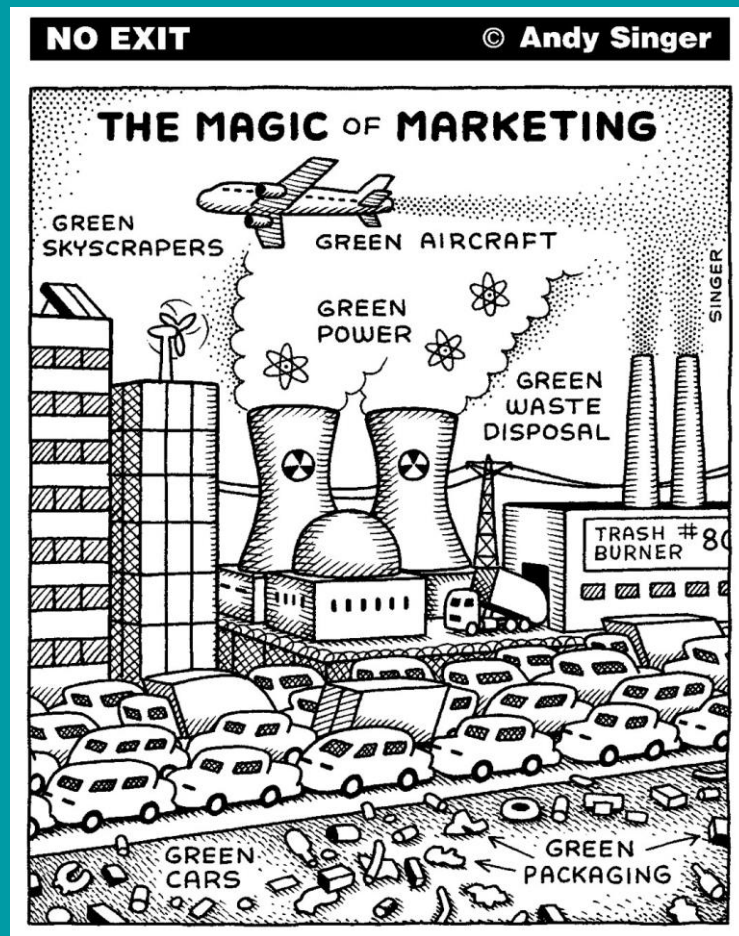


Circularity performance

- a key to the Circular Economy

Dr. Raul Carlsson
Senior researcher
Certification development
RISE Research Institutes of
Sweden



RISE

Ongoing ISO standardization

What is meant with Circular economy

- Common terms and definitions
- Common principles
- Independent of system level

How to make circular economy

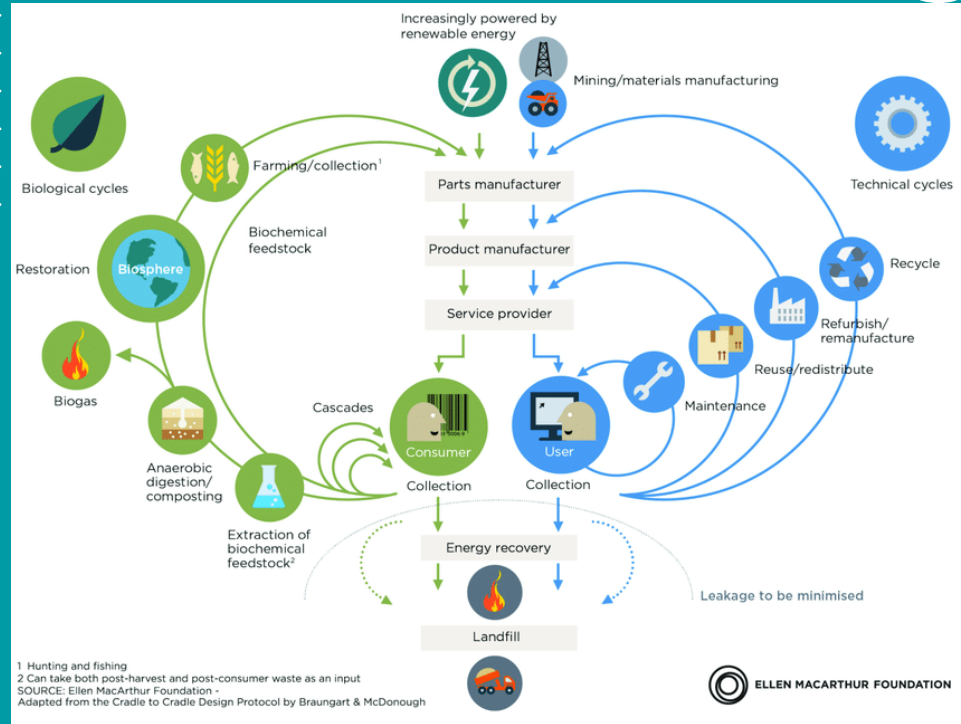
- Guidance

To measure circularity

- How circular is a circular action
- What is product lifetime
- What is a resource value

How to link circular value chains and value networks

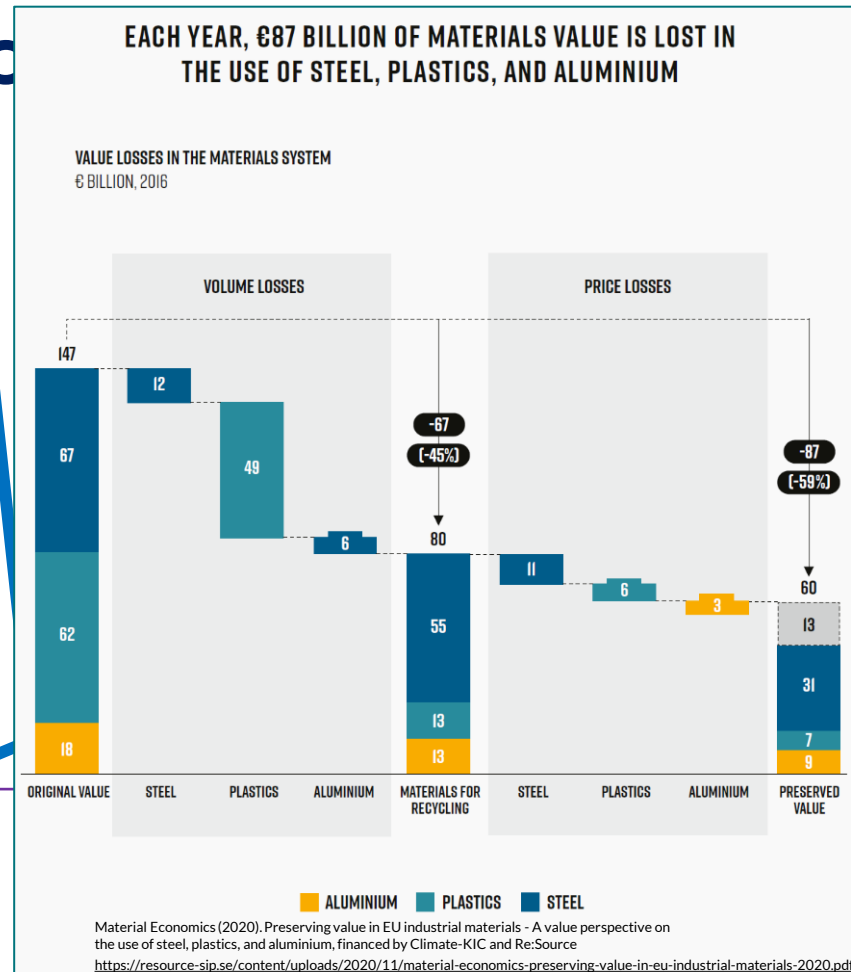
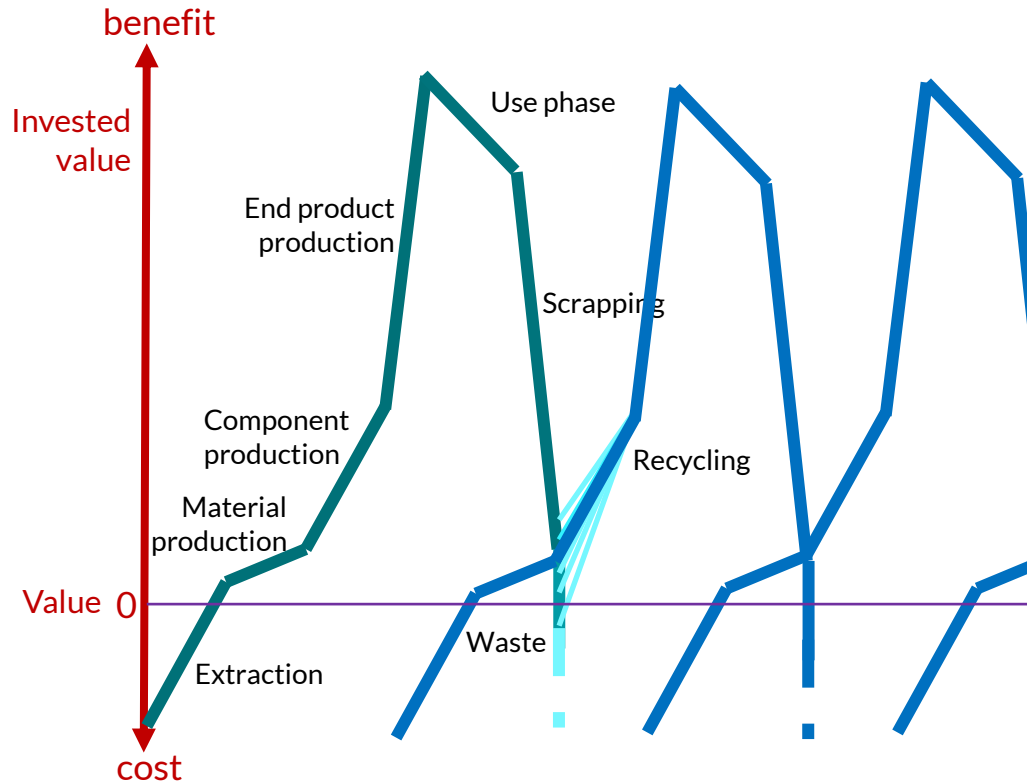
- Information exchange standards



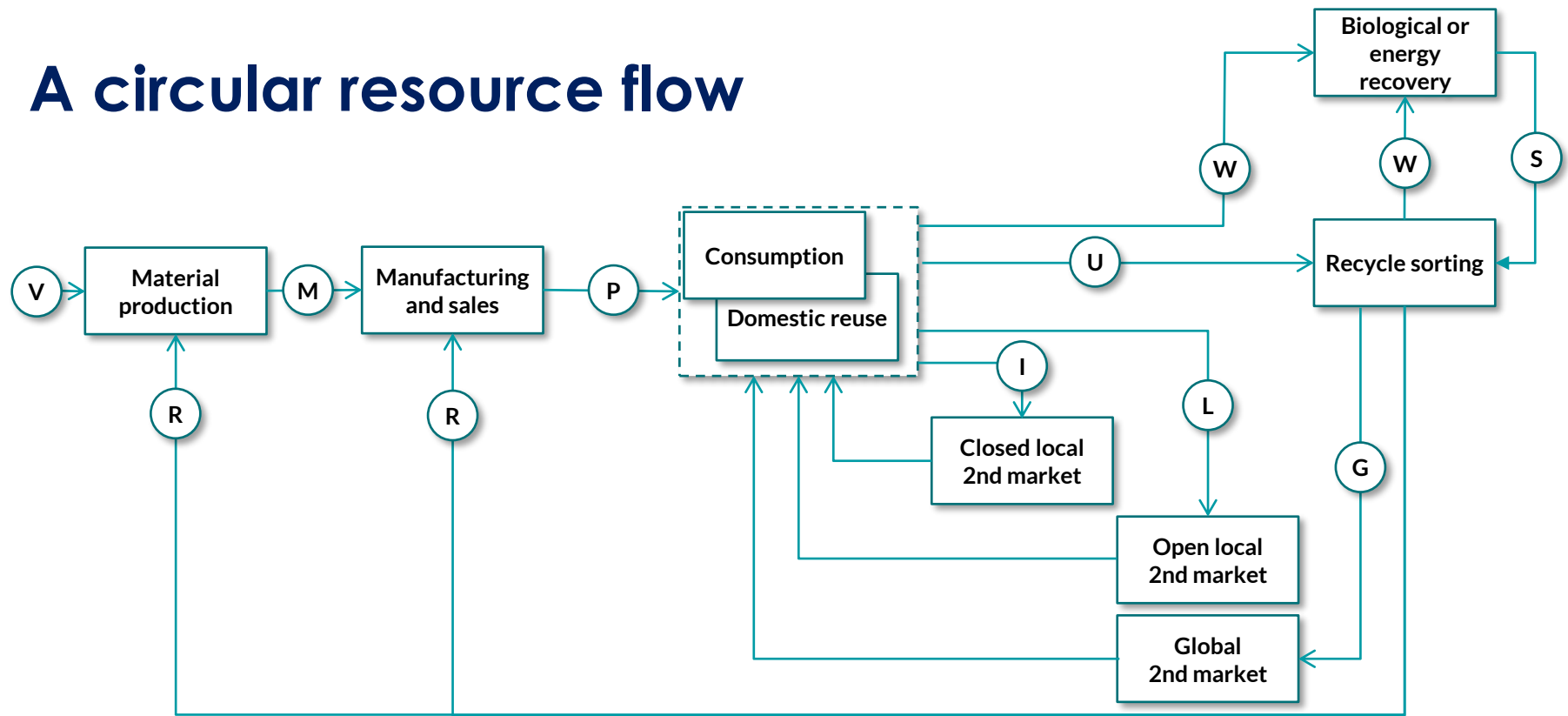
¹ Hunting and fishing
² Can take both post-harvest and post-consumer waste as an input
 SOURCE: Ellen MacArthur Foundation -
 Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

The economy behind circular

The value roller-coaster of the linear economy

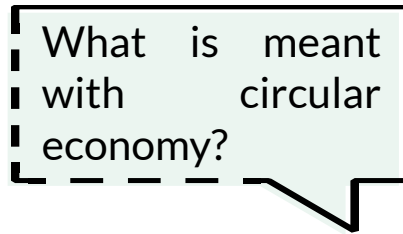


A circular resource flow



V: Virgin material
 R: Re-X material/component
 M: Raw material
 P: Product
 I: Internal re-use

L: Re-use open market
 U: Used product
 G: Re-use formal market
 W: Waste
 S: Surplus from recovery



What is meant
with circular
economy?

Ongoing standardization

ISO/TC323 Circular economy

Setting circular economy into a globally coordinated practice

- Establishing key definitions
- Guide circularity improvement action
- Guide circularity performance
- How to close the loop
- ISO 59004 – Terminology, Principles and Framework for Implementation
- ISO 59010 – Guidelines on business models and value chains
- ISO 59020 – Measuring and assessing circularity
- ISO 59031 – Analysis of case studies
- ISO/TR 59032 – Review of business models
- ISO 59040 – Product circularity data sheet

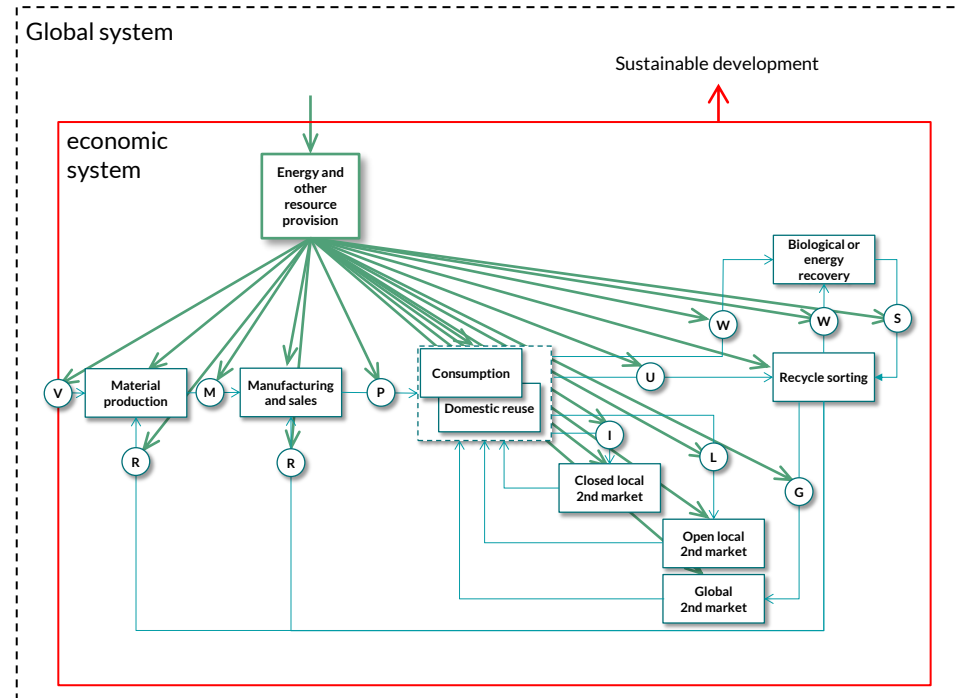
Standardization

circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)



Maintain a circular resource flow

circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)

- Examples
 - Maintain a circular flow
 - Acknowledging resource use
 - Record resource use
 - Establish metrics
 - Establish statistics
 - Establish circularity targets

Maintain a circular resource flow

circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)

- Examples
 - Regenerating
 - Acknowledging natural resources
 - Acknowledging biodiversity
 - Ensuring sustainability of renewable resources
 - Ensuring that resource values are regenerated through renewable resources

Maintain a circular resource flow

circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)

- Examples
 - Retaining
 - Slowing resource throughput
 - Slowing resource value loss
 - Maintaining, servicing
 - Upgrading
 - Refurbishing
 - Remanufacturing

Maintain a circular resource flow

circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)

- Examples
 - Adding to their value
 - Increased utilization rate
 - Right resource for right value

Contribute to sustainable development

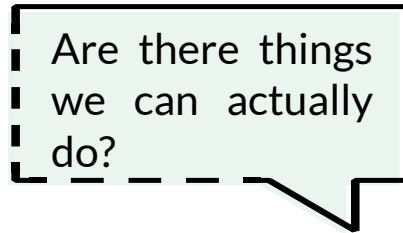
circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development

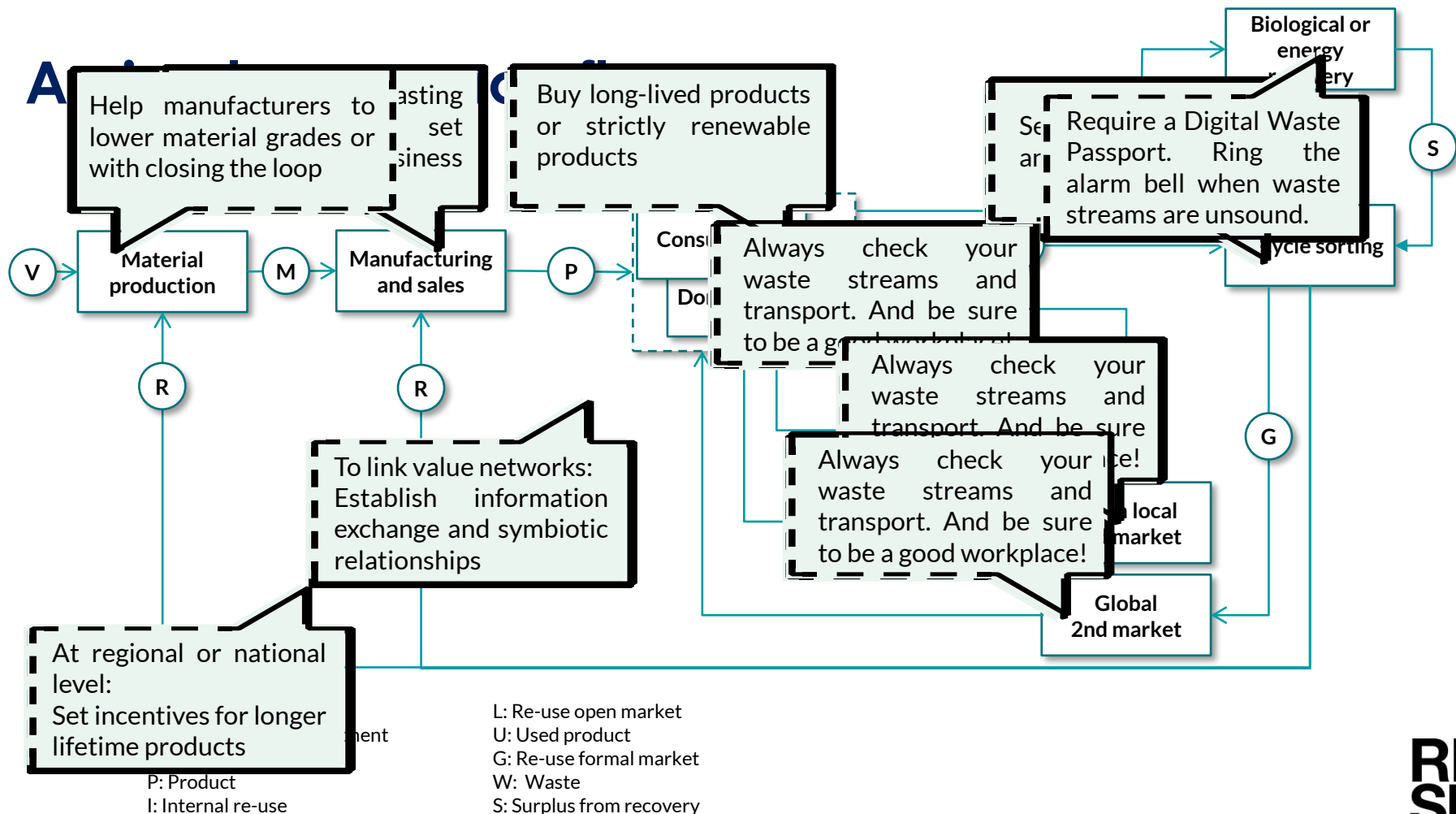
Note 1 to entry: Resources can be considered concerning both stocks and flows.

Draft definition ISO 59004 –WD2 (Jan, 2022)

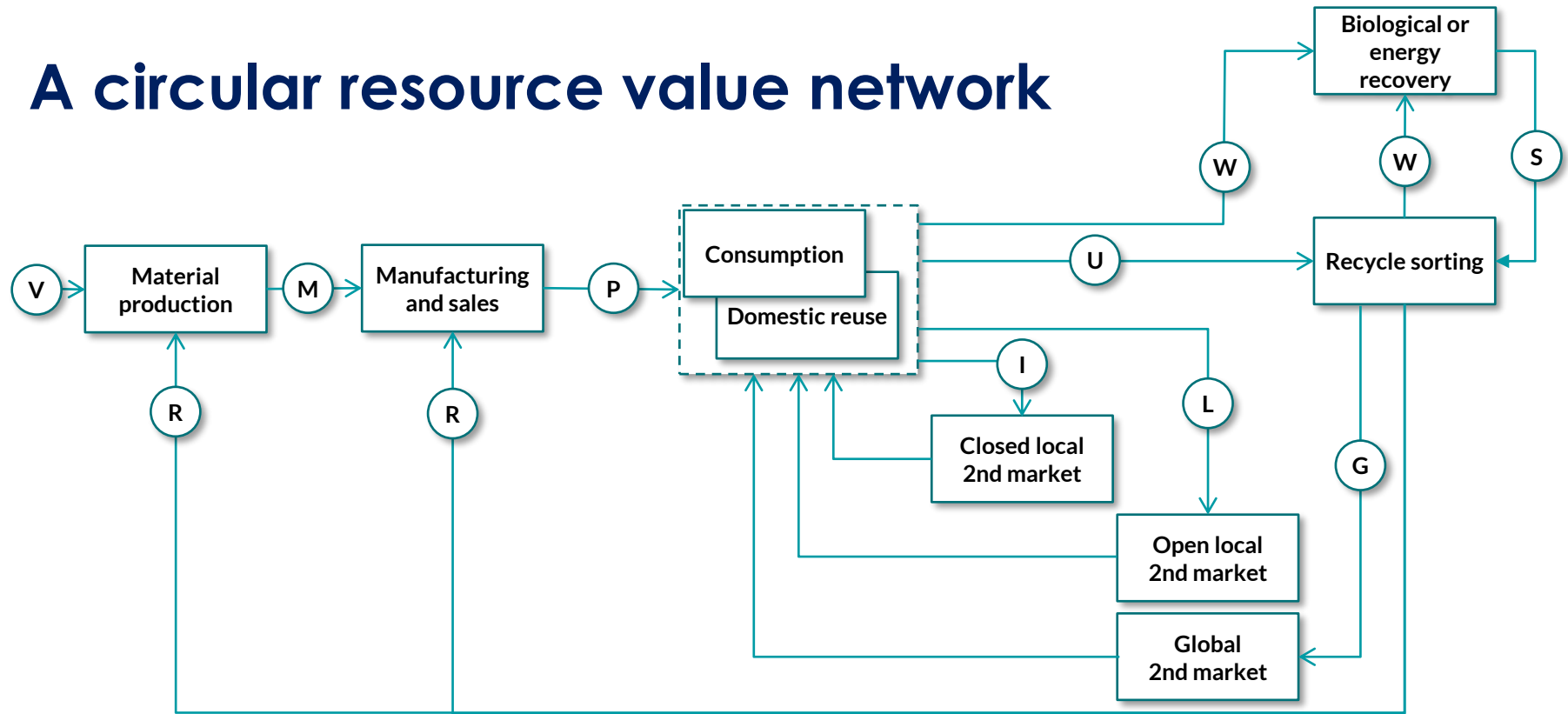
- Contributing to sustainable development, at system level
 - Not increase resource losses
 - Not increase environmental impacts
 - Not harm social or physical health because of circular actions
 - Apply principles and tools, such as
 - ISO 26000 Social responsibility
 - UN Sustainable development goals
 - ISO 14040 Life cycle assessment, including ISO 14067 Carbon footprint, ISO 14046 Water footprint, ISO 14075 Social Life Cycle Assessment, and more



Are there things
we can actually
do?



A circular resource value network



V: Virgin material
 R: Re-X material/component
 M: Raw material
 P: Product
 I: Internal re-use

L: Re-use open market
 U: Used product
 G: Re-use formal market
 W: Waste
 S: Surplus from recovery

Non exhaustive list of examples of actions that illustrates the areas of action

Standardization

area(s) of action

action(s) that can be undertaken at some defined step of the value chain or value network

sphere of influence

range/extent of political, contractual, economic or other relationships through which an organization has the ability to affect the decisions or activities of individuals or organizations

Note 1 to entry: The ability to influence does not, in itself, imply a responsibility to exercise influence.

[SOURCE: ISO 14006:2020, 3.8, modified – Note 2 to entry has been removed.]

Draft ISO 59004 and draft ISO 59010

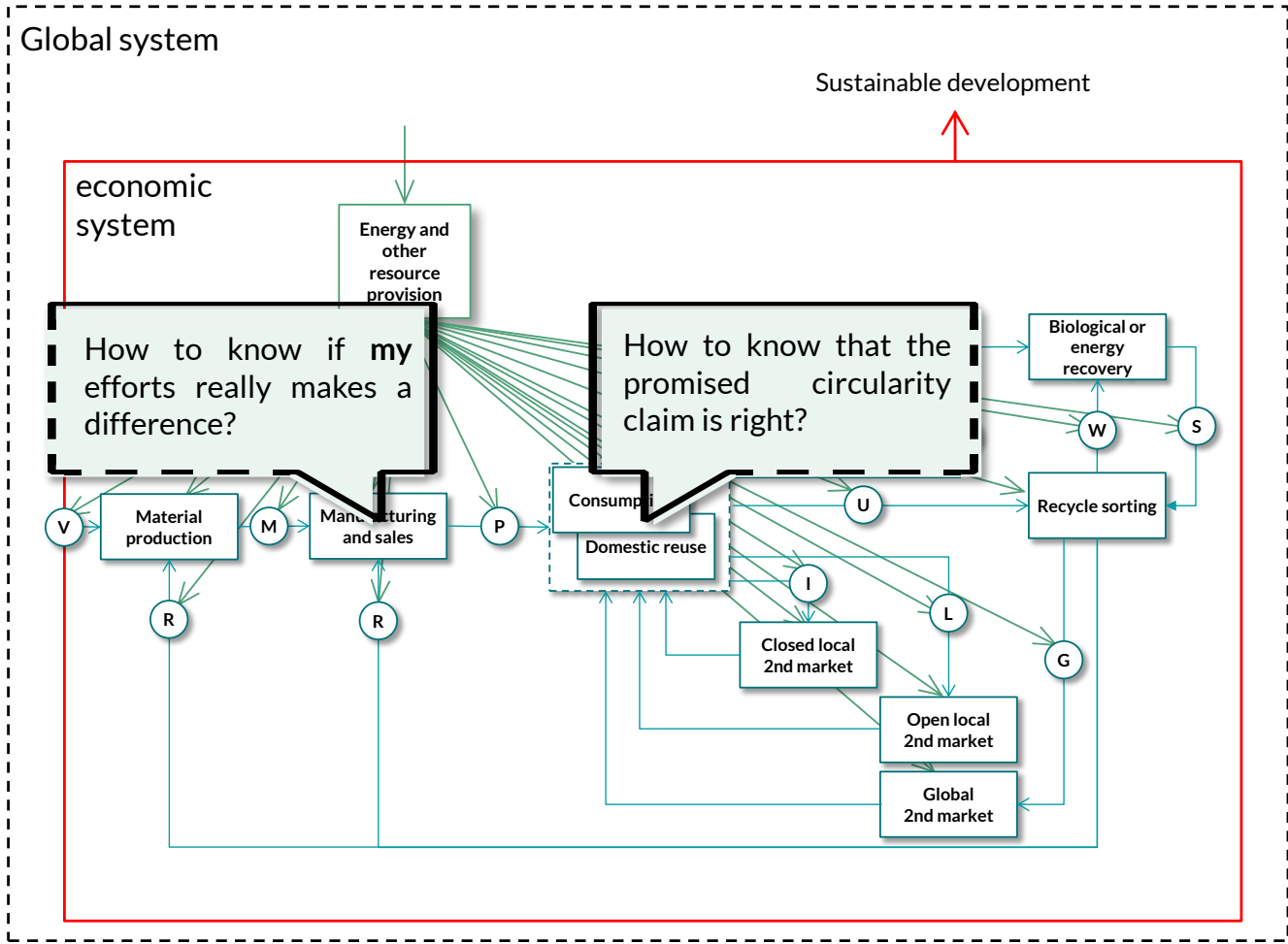
Action	Area of action						
	Ecodesign	Resource management	Procurement	Industrial and territorial symbiosis	Solution provision	Reverse logistics	Education
Foster the reduction of use of resources	X	X	X	X			X
Foster the use of renewable resource	X	X	X	X			X
Foster the use of recovered resources	X	X	X	X		X	X
Design for reuse, for remanufacturing, for repairing	X	X		X			
Use of biomimicry approach	X			X			
Develop multi-functional solutions	X				X		
Implement sustainable forest management		X					
Implement decision making criteria with a CE approach	X	X	X				
Reuse, remanufacturing, refurbishing, repairing of products	X	X	X		X	X	
Extend the lifetime of the solutions	X	X			X		X
Use internet of things technology to optimize productions, maintenance and logistics		X			X	X	
Implement integrated water management practices (reuse, recycle)		X		X			
Utilize other organization's recovered resources		X		X			
Foster for separation in origin		v				v	v

(source: ISO 59004:2023 WD2 Annex B)



How do I know the
circular
performance?

Measure the circularity performance of the system influenced by specific circularity actions.



Measure the circularity performance of the system influenced by specific circularity actions.

5. Assess the total systems study to summarize a circularity performance of the circularity action

system

Sustainable development

4. Use appropriate methods and models to assess contribution to sustainable development

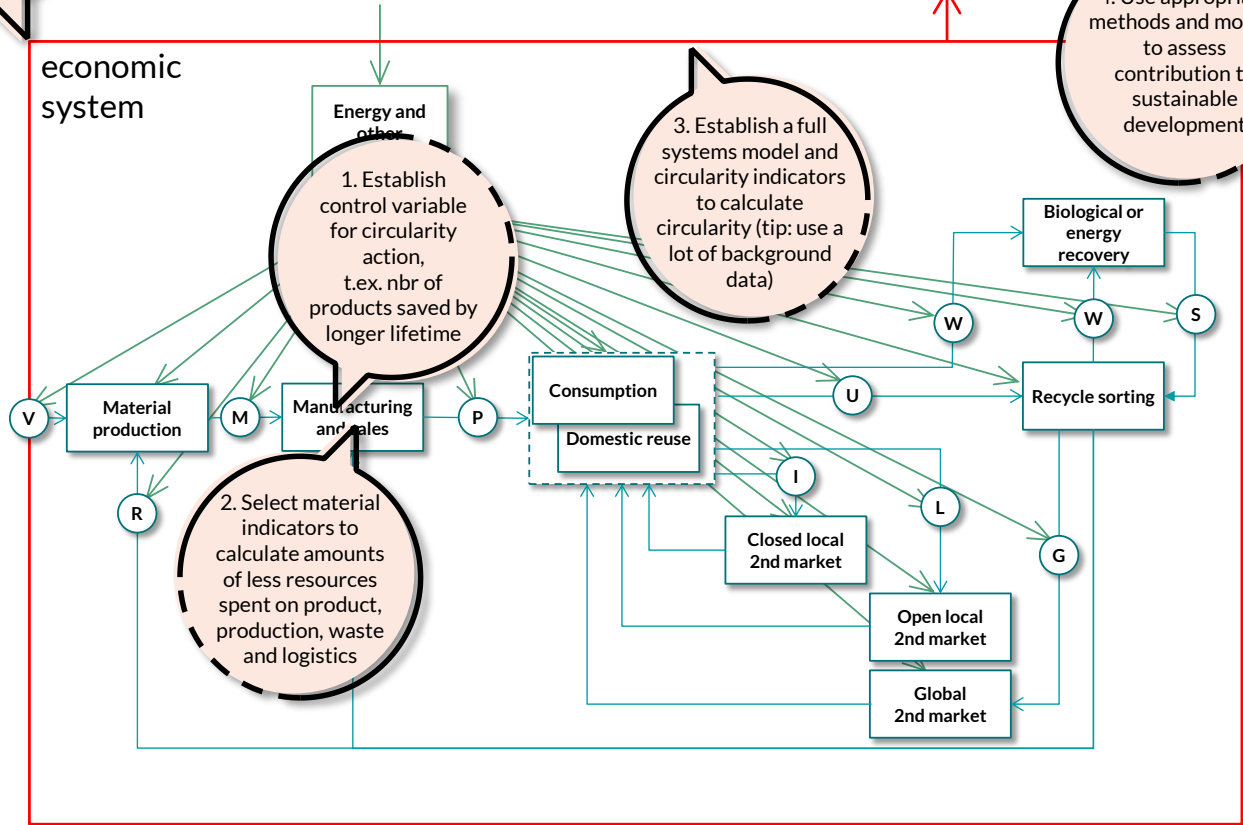
3. Establish a full systems model and circularity indicators to calculate circularity (tip: use a lot of background data)

1. Establish control variable for circularity action, t.ex. nbr of products saved by longer lifetime

2. Select material indicators to calculate amounts of less resources spent on product, production, waste and logistics

How to know that the promised circularity claim is right?

How to know if my efforts really makes a difference?

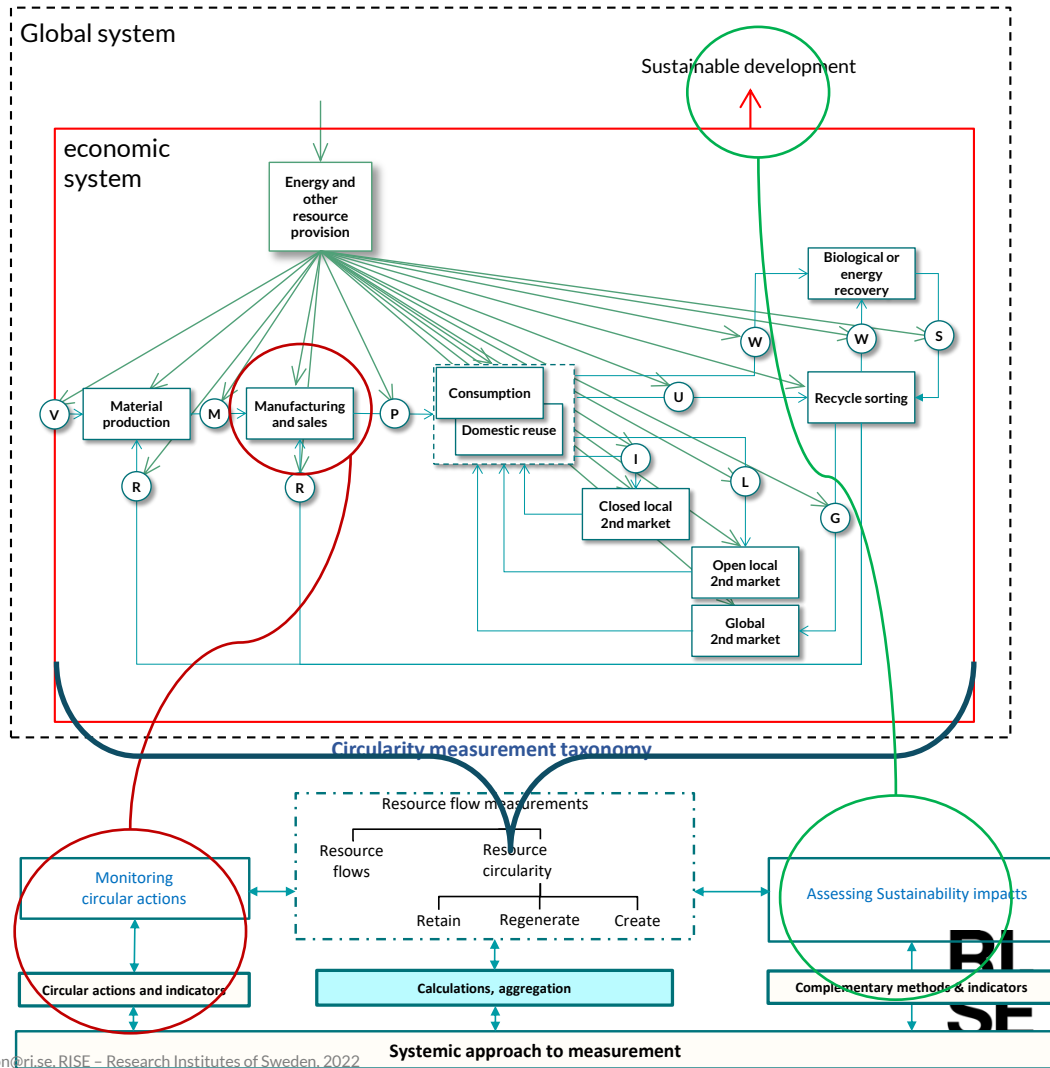


Standardization

ISO 59020 – Measuring and assessing circularity

Provides the method to calculate and assess the circularity performance of a system influenced by a circularity action

taxonomy circularity measurement



Standardization

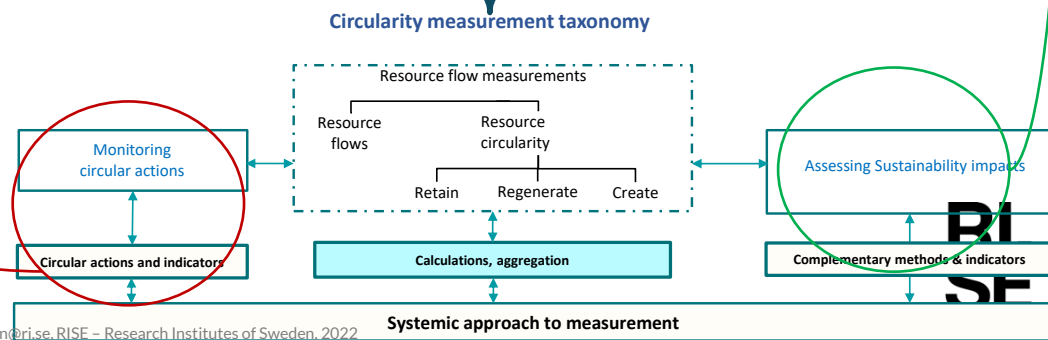
- Circularity action control variables, such as
- Decreased amount of material in product
 - Increased share of recycled material
 - Prolonged product lifetime
 - Number of users per leasing contract

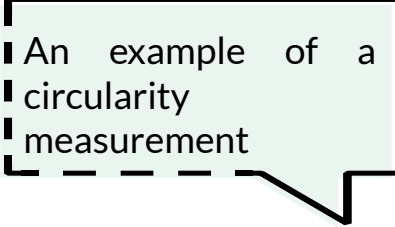
Indicators, such as

- Improved work conditions for workers
- Increased economy based on sustainable innovations
- Reduced amount of GHG emissions
- Reduced amount of biodiversity degradation

Indicators, such as

- Amount of used primary resources
- Amount of used recycled resources
- Quantification of slowed down resource flow
- Quantification of regenerated biodiversity
- Quantification of created value





An example of a
circularity
measurement

From the Vinnova project Trace Certainty: RISE, Linköping University and SKF

Testing metrics for measuring the circularity while metrics are being standardized -
TRACE CERTAINTY TRAnsitioning to a Circular Economy via CERTificAtion in
INdusTrY : PROJECT FINAL REPORT Reference Number 2020-04410

Verification of system's circularity

From the Vinnova project Trace Certainty: RISE, Linköping University and SKF

ISO 59020 refers to ISO 59004, which defines *circular economy* as an “economic system that uses a systemic approach to maintain a circular flow of resources, by regenerating, retaining or adding to their value, while contributing to sustainable development”.

1. Do we see systematic maintenance of a circular flow of resources?
2. Do we see regenerating resource values?
3. Do we see retaining resource values?
4. Do we see adding to resource values?
5. Do we see contribution to sustainable development?

1. Systemically Maintains a Circular Flow of Resources

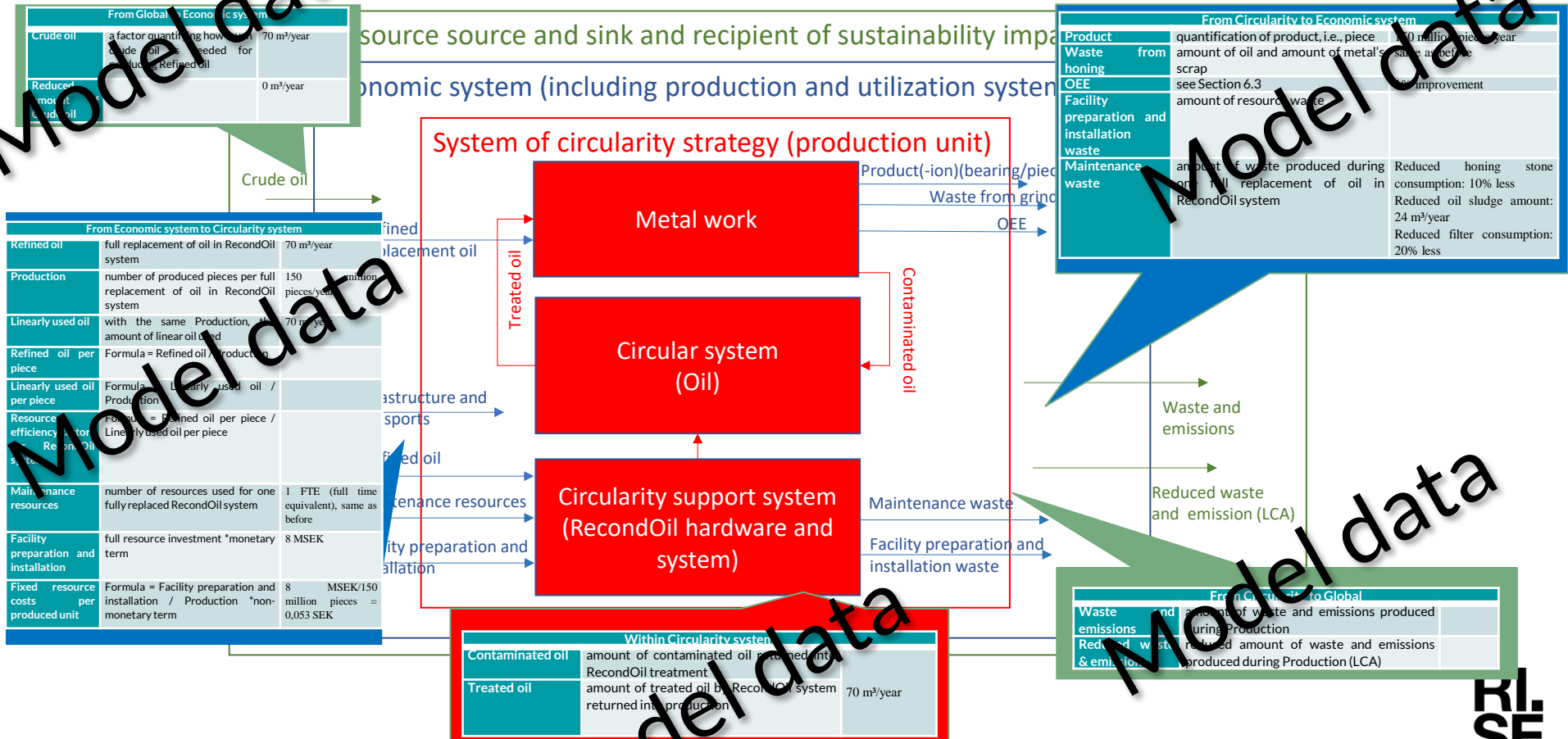


Figure 2. General system model with RecondOil parameters

2. Adding resource value

$$OEE = Availability \times Performance \times Quality$$

Case study of SKF RecondOil: OEE – 1% improvement

Model data

3. Retaining resource value

$$\text{RecondOil retainment factor per piece} = \frac{\text{Treated oil per piece}}{\text{Linearly used oil per piece}} \times 100$$

$$\text{RecondOil retainment factor per piece} = \frac{2000}{40} \times 100\% = 5000\%$$

4. Regenerating resource value

$$\text{Oil regeneration factor} = \frac{\text{Treated oil per piece}}{\text{Refined replacement oil per piece}}$$

$$\text{Oil regeneration factor} = \frac{2000 \text{ litres}}{40 \text{ litres}} = 50$$

Testing metrics for measuring the circularity while metrics are being standardized -
TRACE CERTAINTY TRAnstitioning to a Circular Economy via CERTificAtion in
INDusTrY : PROJECT FINAL REPORT Reference Number 2020-04410

6. Contributing to sustainable development

Methods, which can measure this indicator, are LCA, sustainability targets (e.g., improving quality of life).

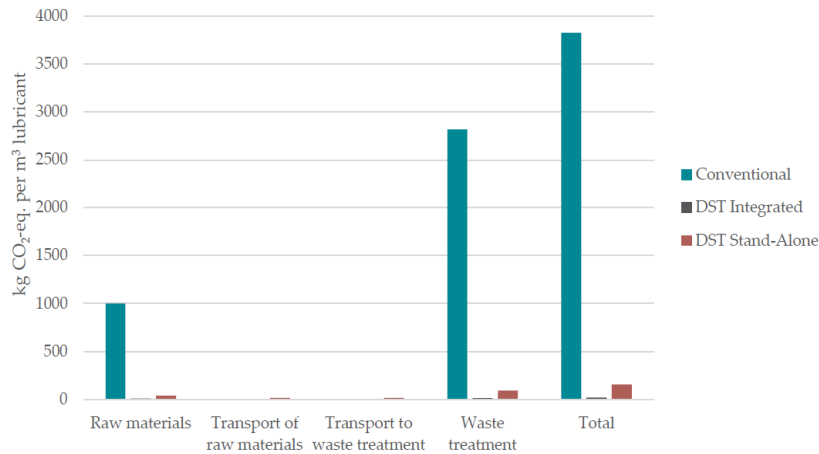


Figure 3. Climate change impact potential of the three studied systems (source: LCA report).

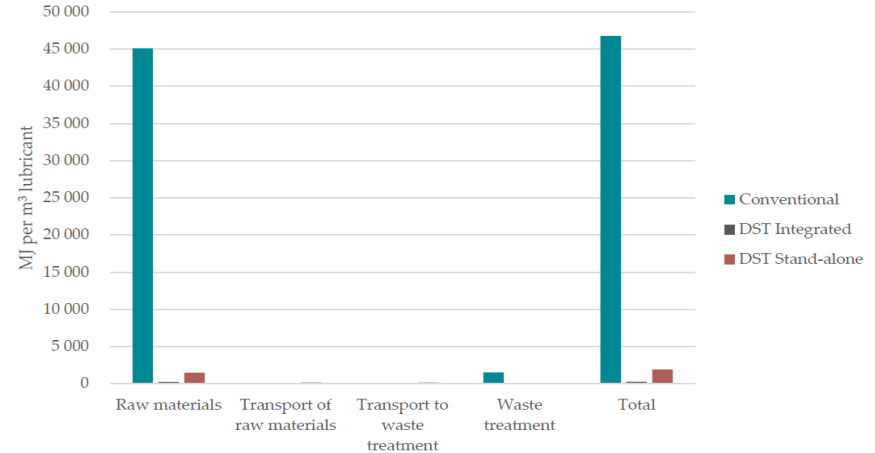
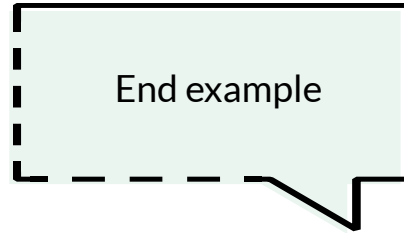


Figure 4. Fossil resource depletion potential of the three studied systems (source: LCA report)

Testing metrics for measuring the circularity while metrics are being standardized -
TRACE CERTAINTY TRAnSitioning to a Circular Economy via CERTificAtion in
INdustry : PROJECT FINAL REPORT Reference Number 2020-04410

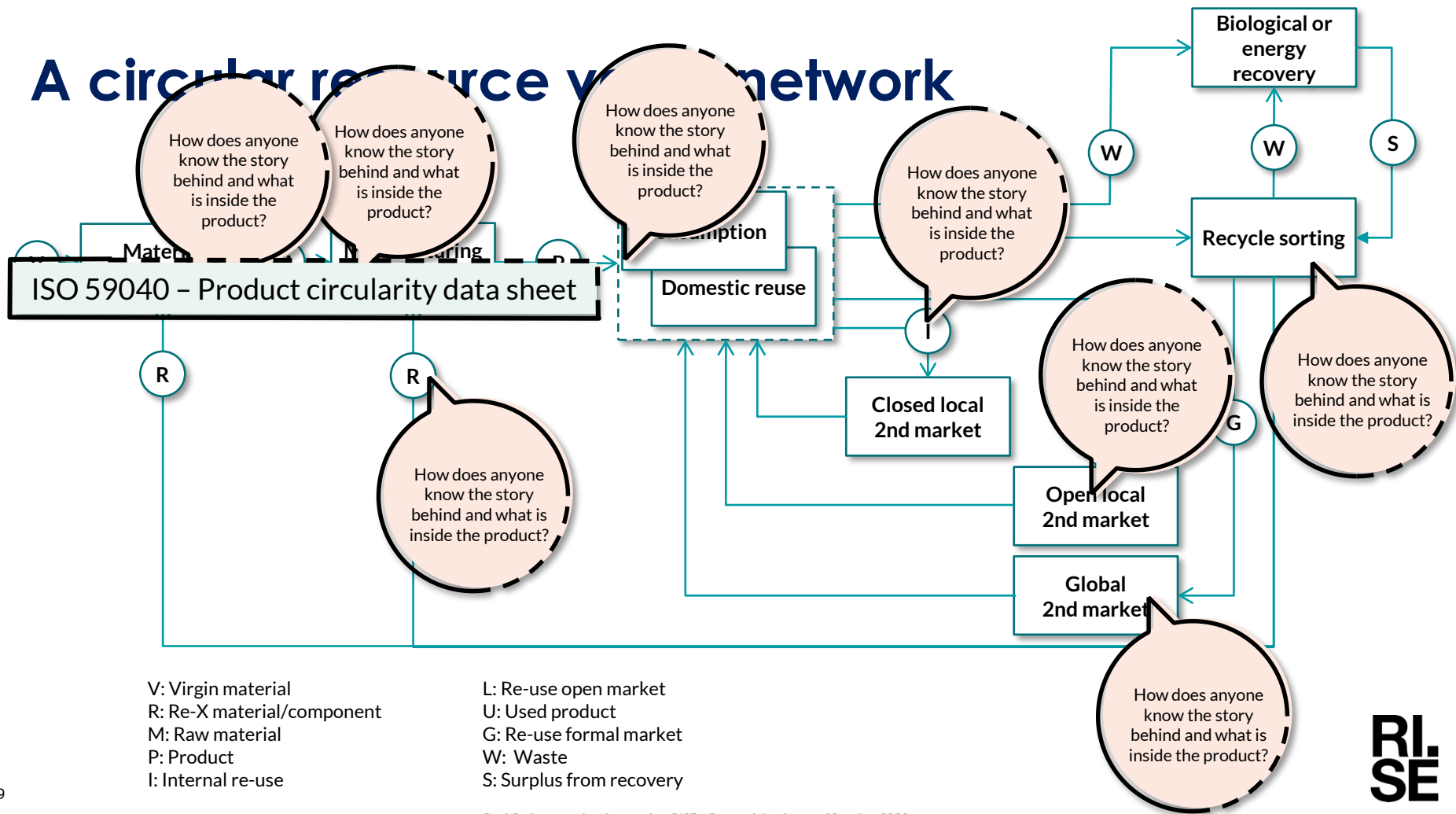
From the Vinnova project Trace Certainty: RISE, Linköping University and SKF



Testing metrics for measuring the circularity while metrics are being standardized -
TRACE CERTAINTY TRAnSitioning to a Circular Economy via CERTificAtion in
INdusTrY : PROJECT FINAL REPORT Reference Number 2020-04410

Circular economy
is a coordinated
action

A circular resource value network



V: Virgin material
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 W: Waste
 S: Surplus from recovery

ISO 59040 – Product circularity data sheet

Data to be exchanged throughout value network, such as

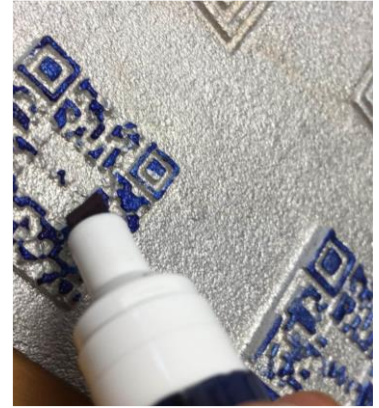
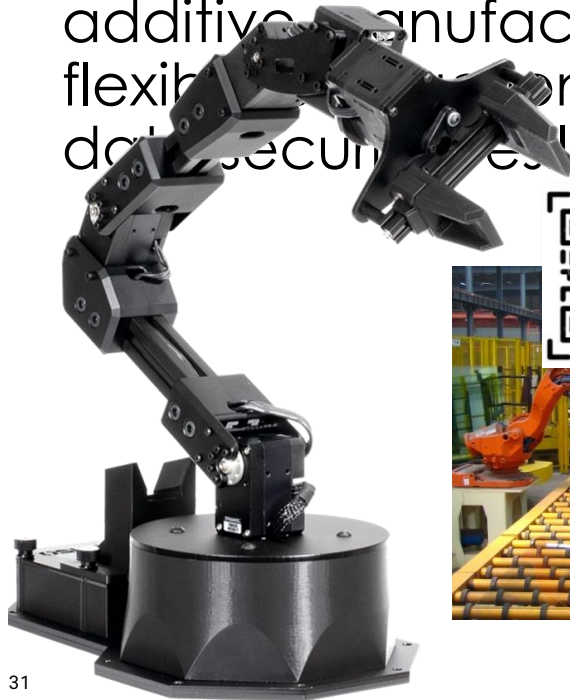
- Materials and component lists
 - Material specifications
 - Component structures
- Service and dismantling guidelines
 - Manuals
- Recycling and re-use requirements
 - Second hand sales channels
 - How to refurbish
 - How to remanufacture
 - How to close recycling loops
- etc.

But what about digitalization?

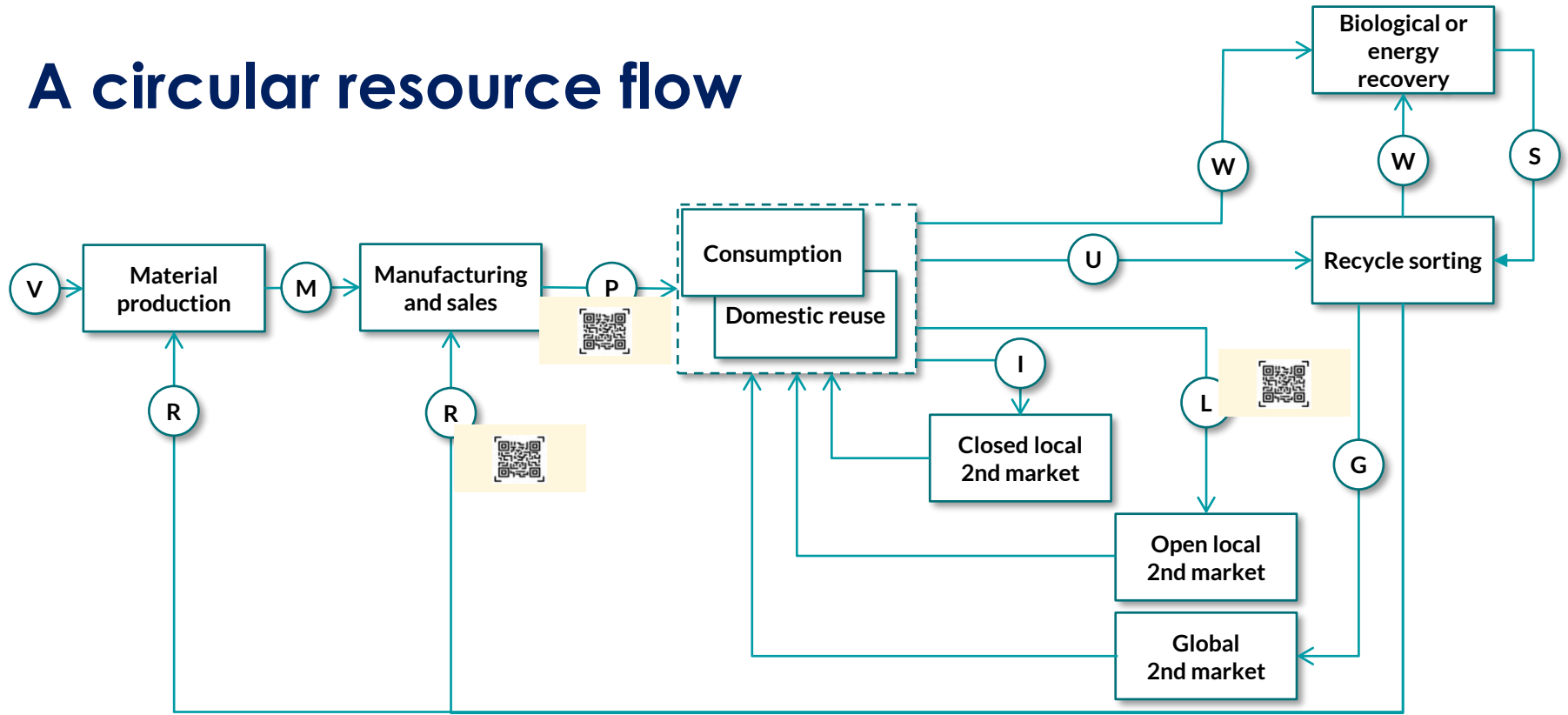
The Product circularity data sheet is likely to match a Digital Product Passport.

But to go beyond into circular automation and industrialization we need more.

Production, dismantling, service, remanufacturing, reverse logistics, sharing economy, digital business models, additive manufacturing, flexible production, data security, resilience,



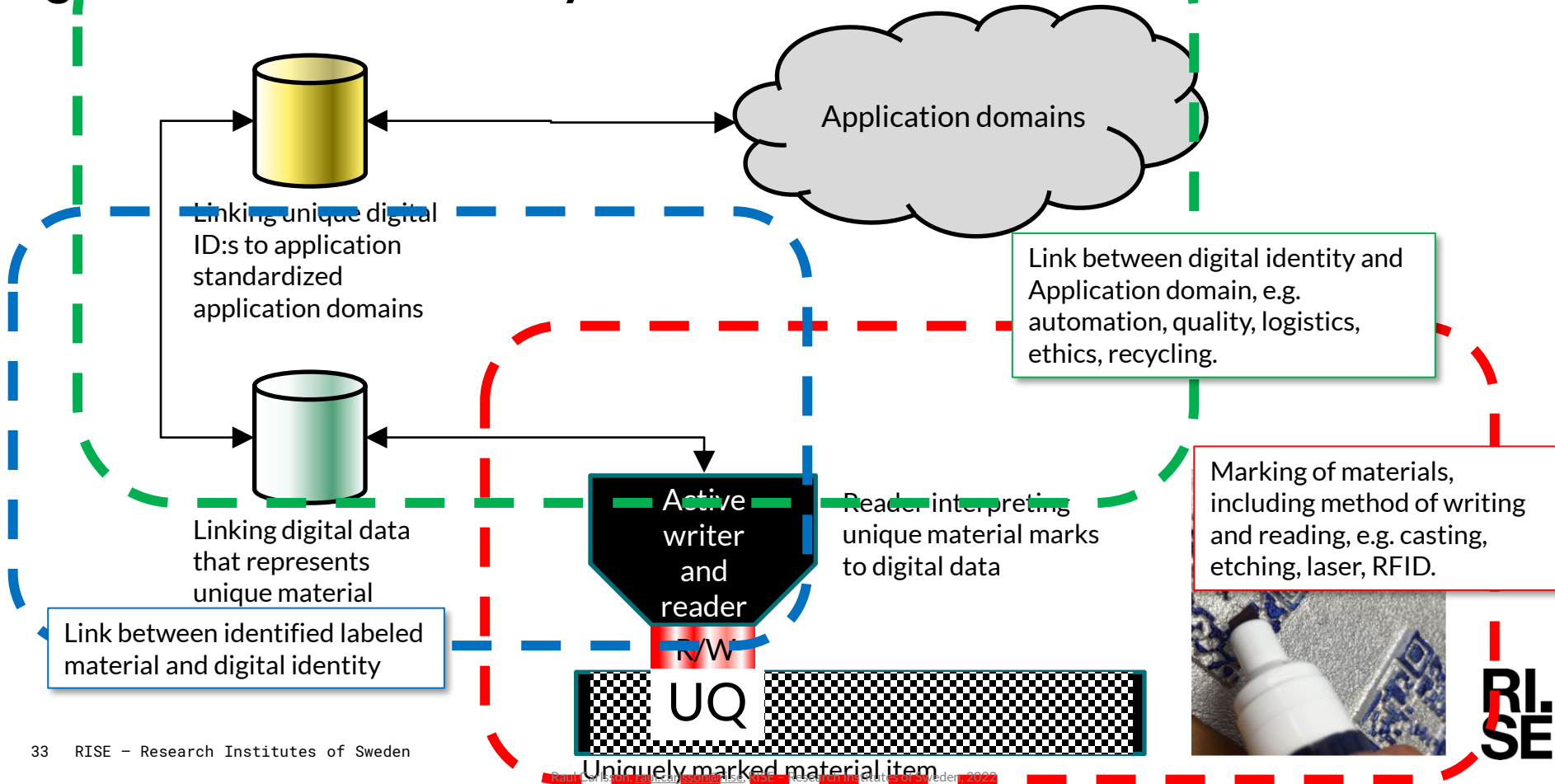
A circular resource flow



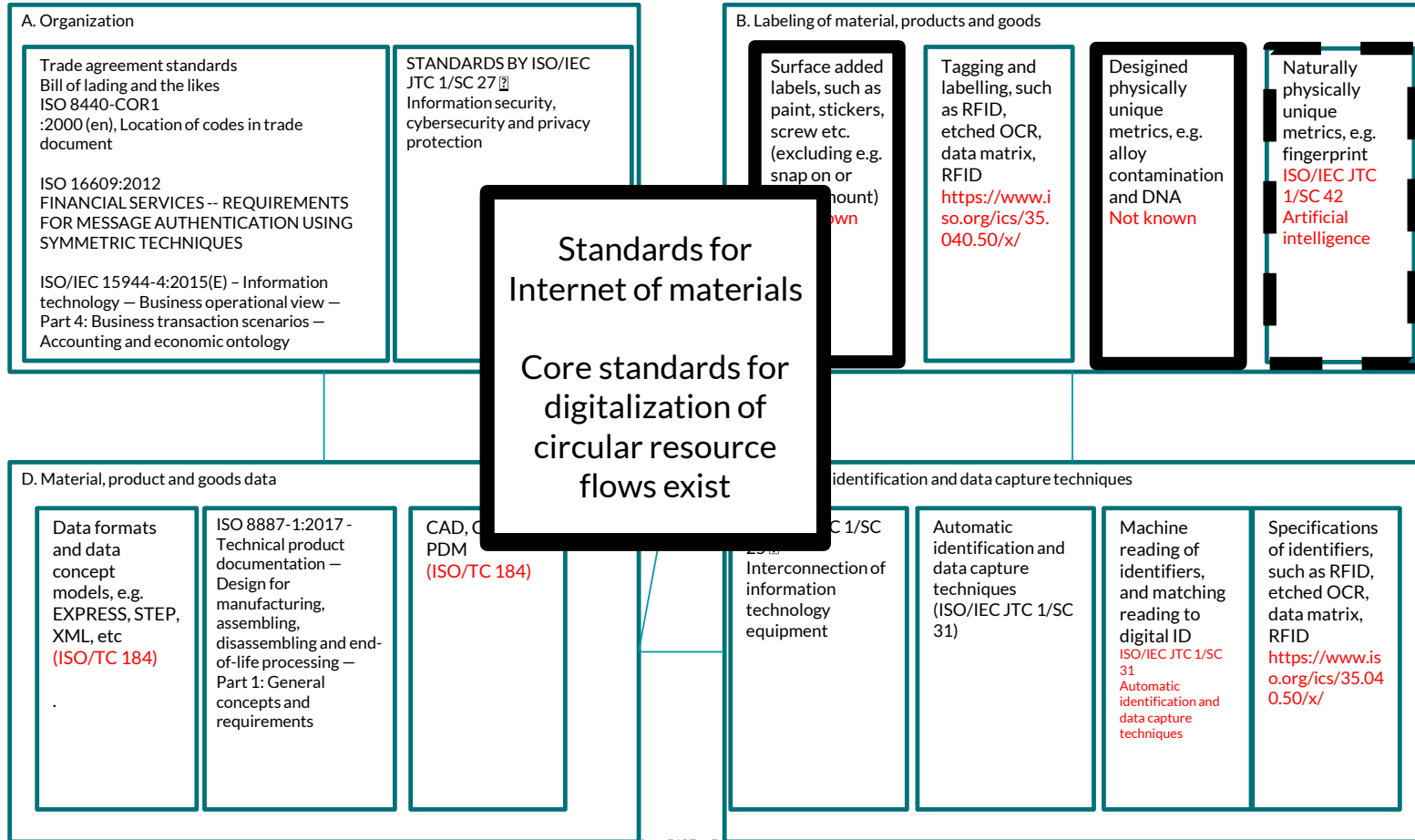
V: Virgin material
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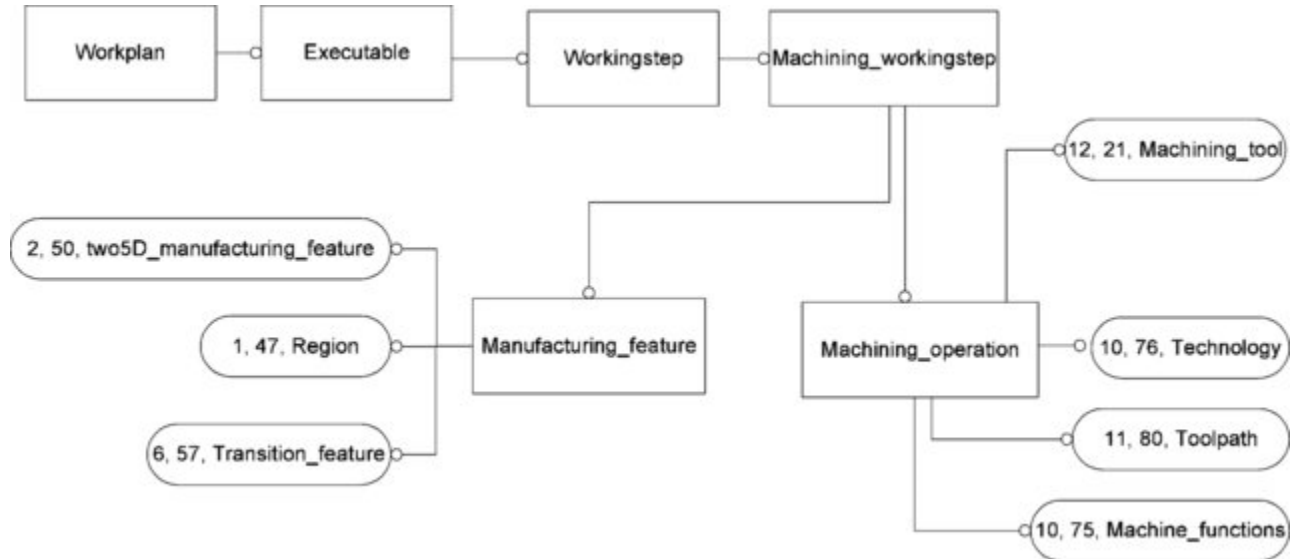
Digital circular traceability of resources – Internet of materials



A standards assessment performed with purpose to identify existing and missing standards for traceability of material resources



STEP EXPRESS



Circular economy
between consumer
and producer?

Mutual understanding and responsibility

Verification



Producer

Standard



Lifetime criteria

Trust

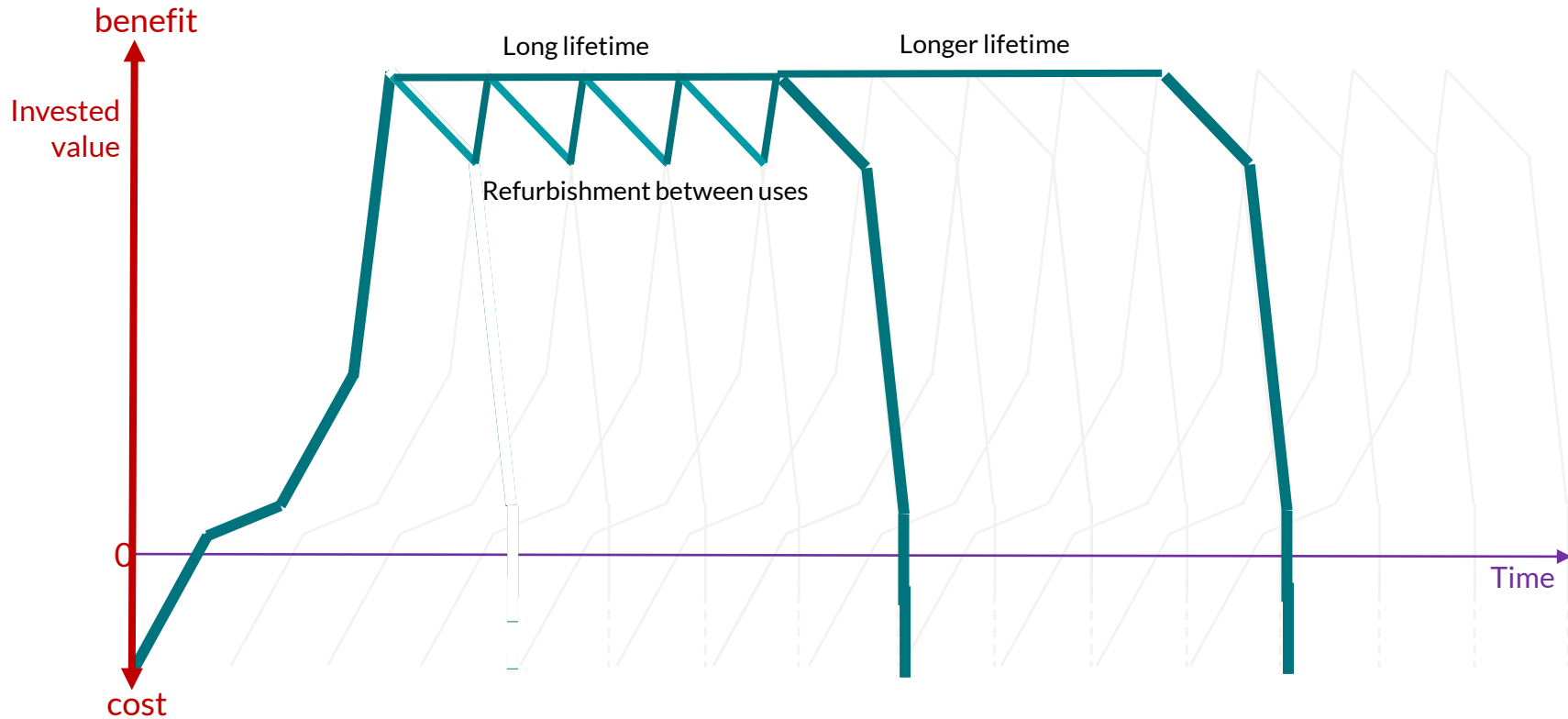


Customer

Standardization is needed to establish trust for the many new ways that products will be given circularity features, such as long and many lives.

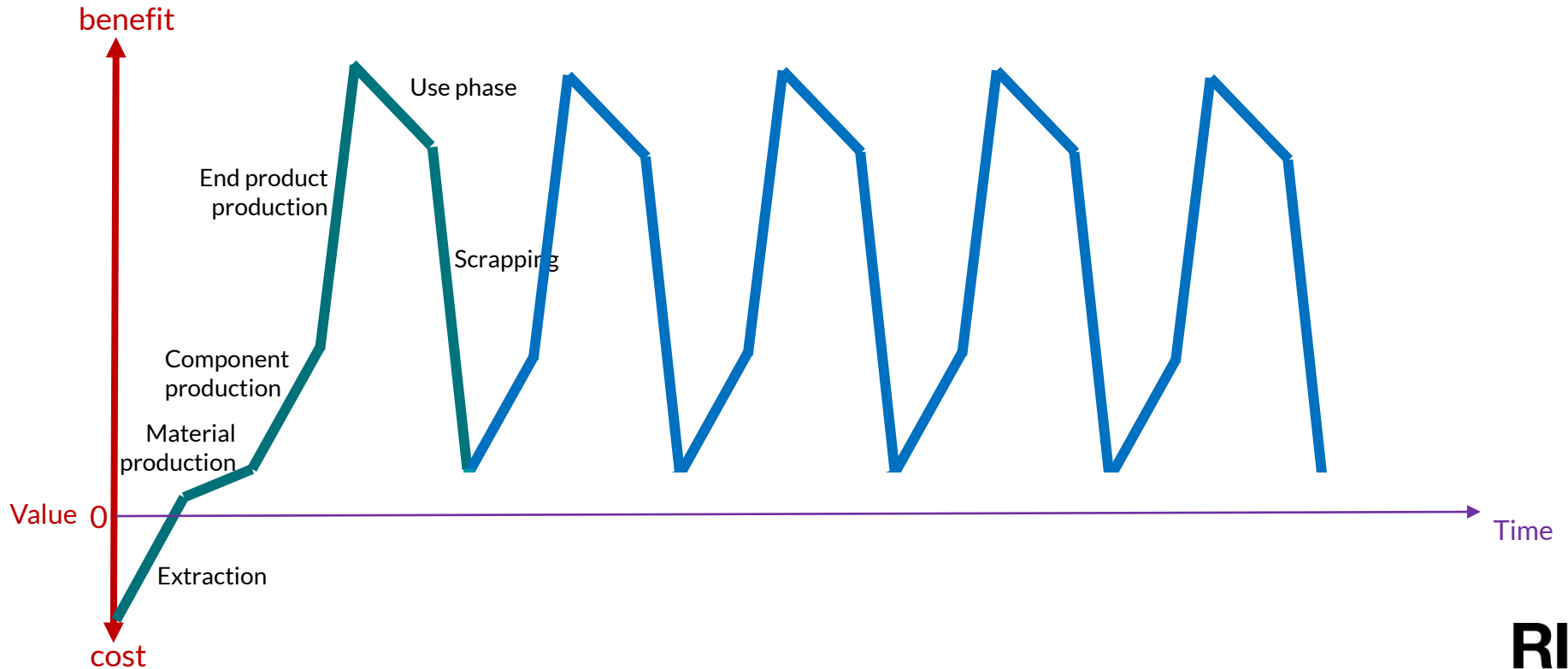
OK, but can we
really have a
circular economy?

Circularity lifetime expansion



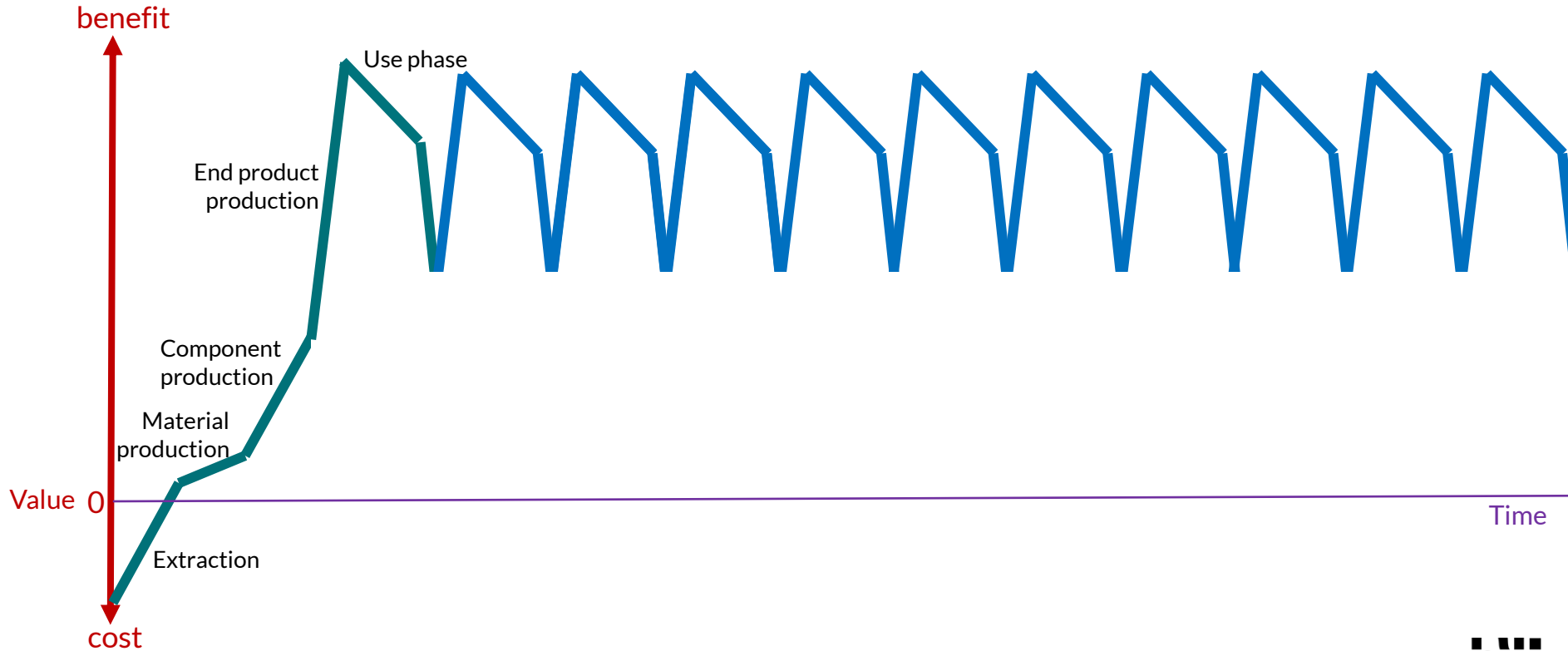
We can close the loops, so we can

Stop the losses of the value roller-coaster of the ~~linear~~ economy



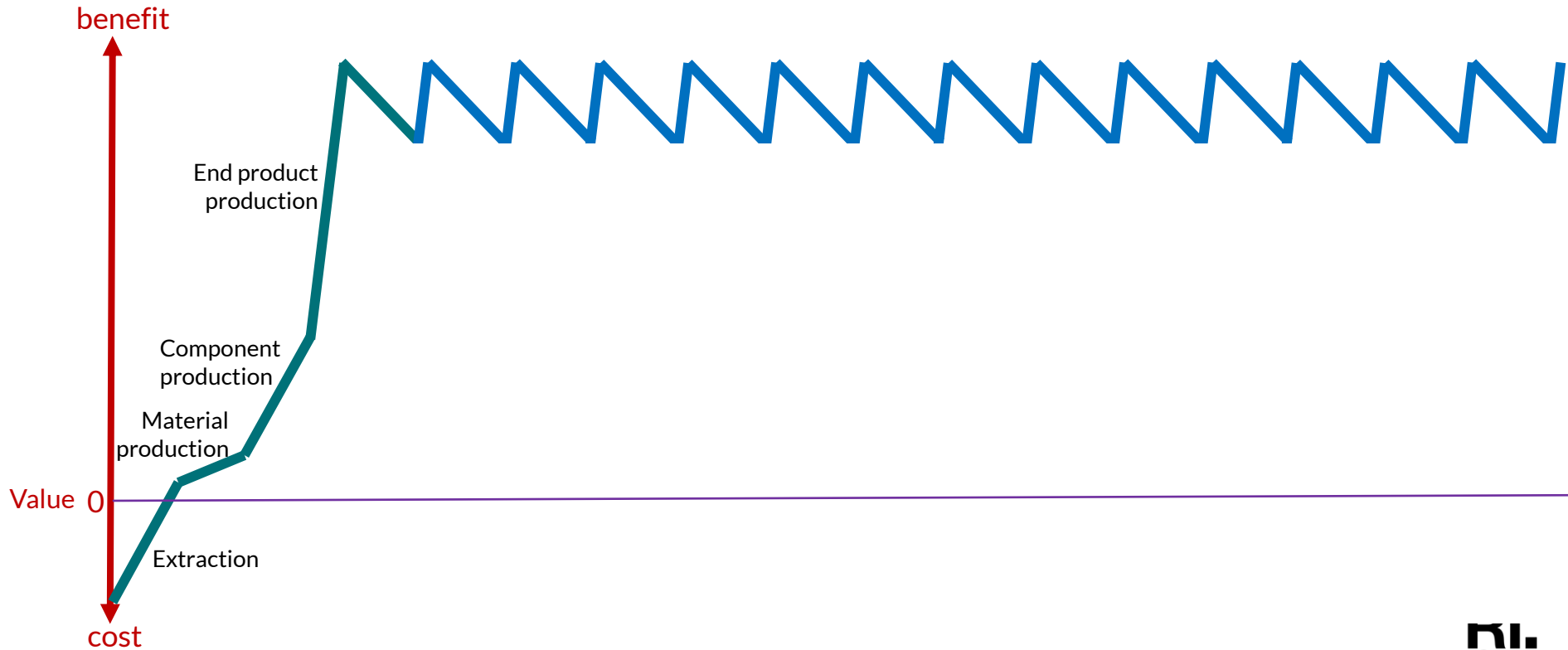
We can design for remanufacturing, so we can

Smoothing the value roller-coaster of the economy



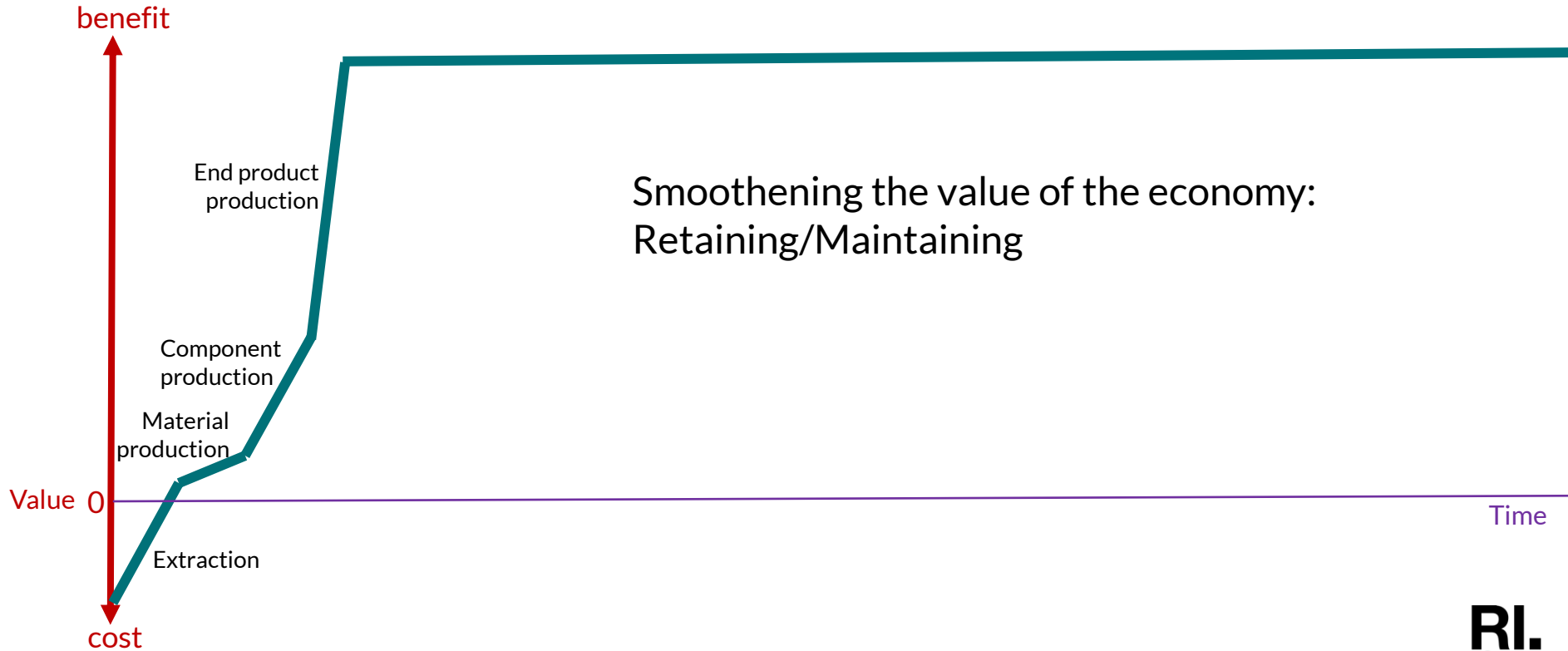
We can design for refurbishment, so we can

Smoothing the value roller-coaster of the economy



We can design for long life, so we can

Really smoothening the value of the economy



We can design for long life, so we can

Enjoy the increasing value economy



In summary

- To measure circularity performance we need clear concepts
- ISO/TC 323 Circular economy – develops crucial standards and clarifies concepts
- Additional standards are needed
 - Coordinated standards for digitalization
 - To reach consumers we will need to be more specific on product lifetime
 - To optimize our systems we will need better control of resource value

**Thank you for your kind
attention!**

**Contact Details
Dr. Raul Carlsson
raul.carlsson@ri.se**

