

Circularity of PHA Processing

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Overview

Circular Economy Principles

Circularity Measurement & Assessment

The ‘System in Focus’

What needs to be measured?

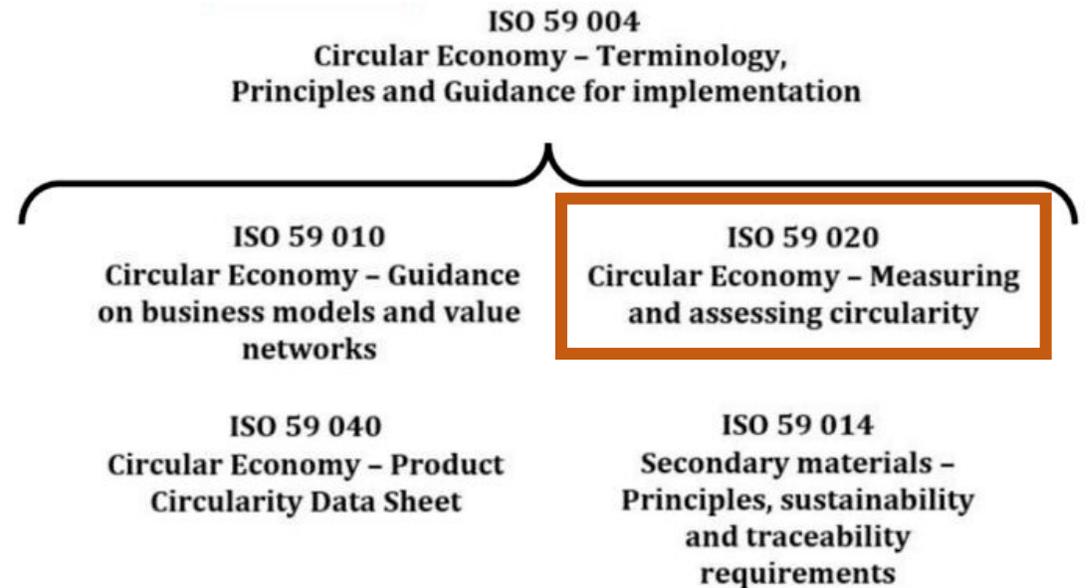
Who benefits from the results?

How does PHA compare to...

Applying Circular Economy Principles



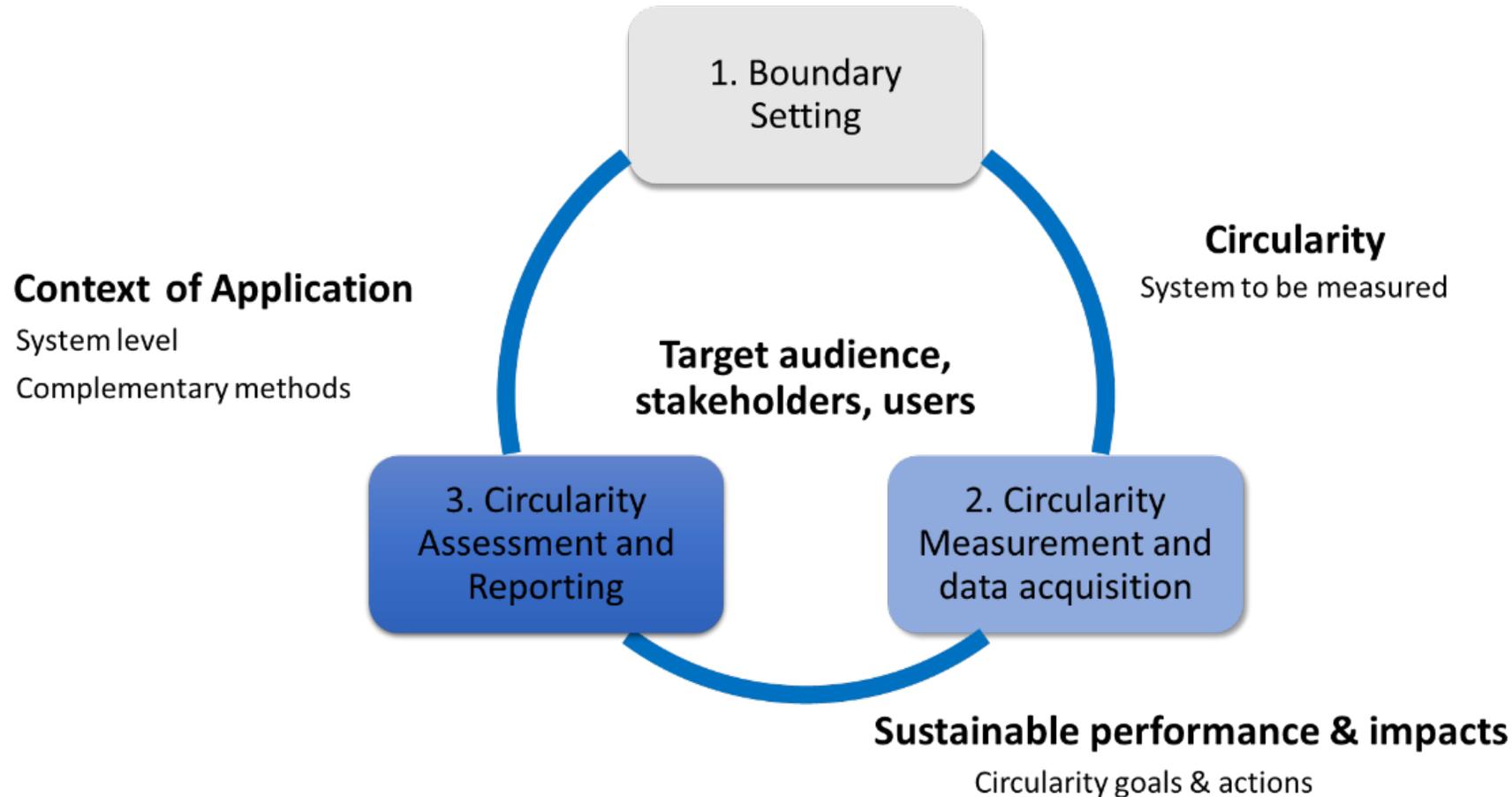
ISO 59000 series



Definition

*“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**”*

Circularity Measurement & Assessment (CMA)



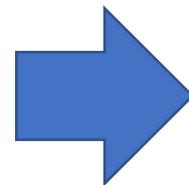
Circularity Measurement & Assessment (CMA)

Aspect	Considerations
Technical	<ul style="list-style-type: none">• It's technology readiness level (TRL) and having an established value chain is less advanced than alternative pathways for primary sludge in its use as a resource.
Economic	<ul style="list-style-type: none">• It can create new job opportunities as the PHA value chain develops.• It may conflict with existing infrastructure for to heat & power generation at treatment facilities.
Social	<ul style="list-style-type: none">• Develop new skills to support PHA production
Environment	<ul style="list-style-type: none">• PHA offers a biodegradable alternative to fossil-derived plastics, whilst helping to reduce waste pathways as a circular resource.• It may reduce the total available fertilizer for crops, leading to increased synthetic fertiliser production.

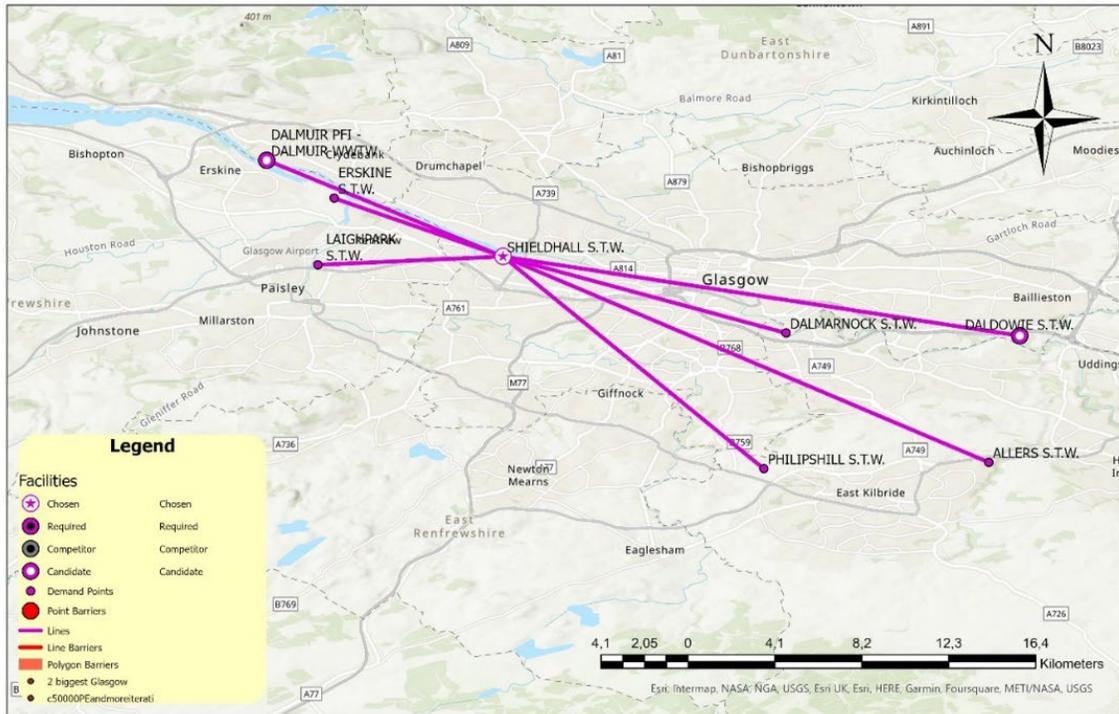
Considerations in the approach to the CMA

The 'System in Focus'

Let's make 'Cake'



The 'System in Focus'



Regional (Scotland)

Valorisation of PHA production in 4 different Scenarios (centralised, decentralised, or stand-alone).

Reference flow: Valorisation of 500,000 tons per year of processed primary sludge.

Functional unit: Valorisation of 1 ton of primary sludge (3-5% dry matter).

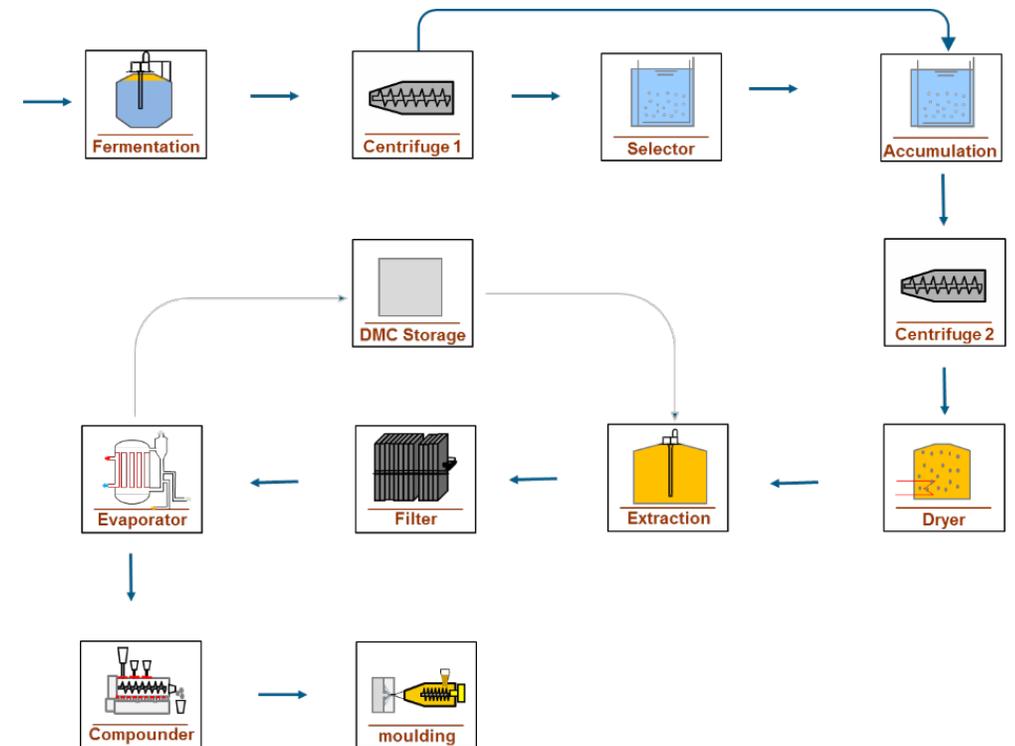
The 'System in Focus'

Process

Provides a benchmark of performance for PHA production in different scenarios.

Allows for comparison with impacts of alternative pathways to produce biogas.

Informs decision-making for stakeholders regarding strategy and investment.



What needs to be measured?

Data requirements

Infrastructural needs

Energy (Electricity, Heat & Steam)

Transport

Raw materials and other resources

Labour costs



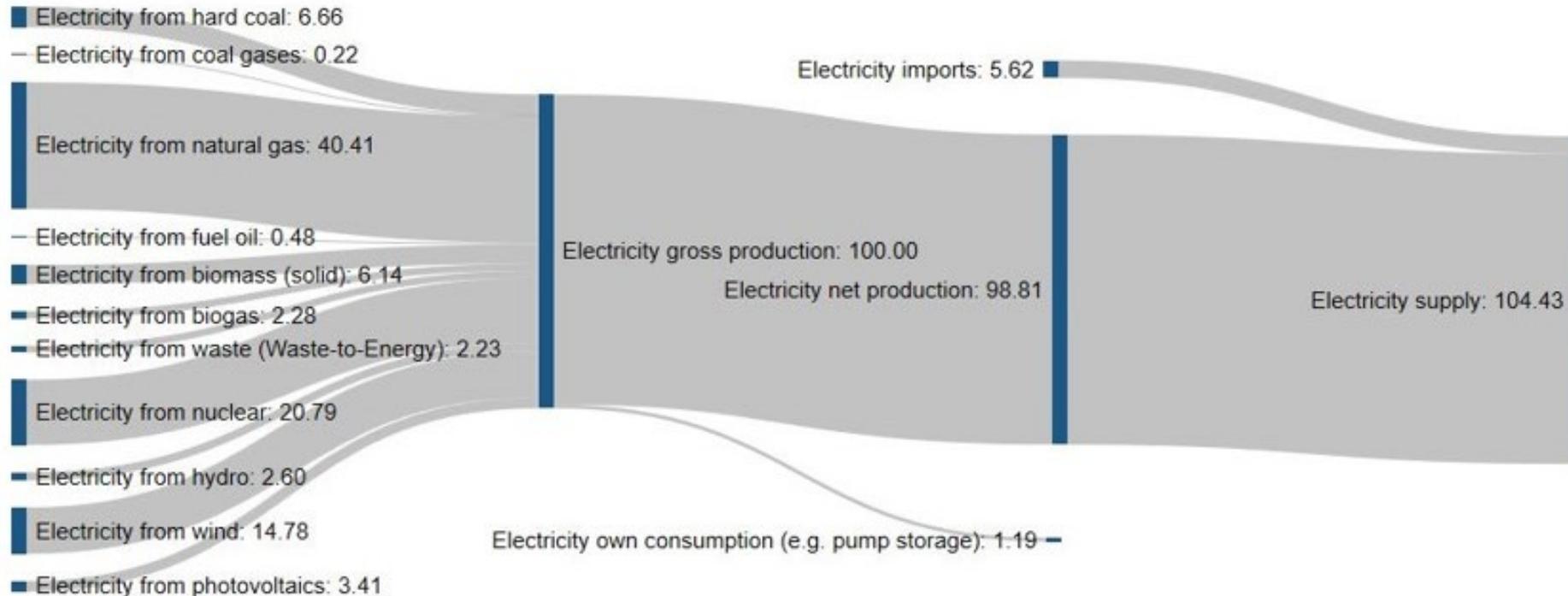
What needs to be measured?

Circularity indicators

Type	Category	Indicator Description
Core (Shall)	Outflow	Average lifetime of product or material relative to industry average
Core (Should)	Energy	Average % of consumed energy from renewable source
Additional	Energy	Percent energy recovered from residual, non-renewable resource outflows
	Economic	Value per mass
	Cost	Investments
		Production costs
	Social	Labour

What needs to be measured?

e.g. % Energy from Renewable Source



>>> **Renewable Energy**

↓

Lower g CO₂ eq. /ton PHA

↓

Costs ???

Who benefits from the results?

Wastewater companies

Places a value on PHA as a sustainable and circular resource.

Presents balanced results for comparison to alternative pathways for primary sludge.

Identify hotspots and provide benchmark to improve circular performance of PHA production.

PHA end-users

Technical, economic, social and environmental quality of PHA cake.

Support business case for PHA as opposed to alternative primary sludge pathways.

How does PHA compare to...

Indicator Description	PHA	Plastic
Average lifetime of product or material relative to industry average	✓	✓✓✓✓✓
Average % of consumed energy from renewable source	✓✓✓	✓
Percent energy recovered from residual, non-renewable resource outflows	✓	✓✓✓
Value per mass	€€€	€
Investments	€€€	€€€
Production costs	€€€	€
Labour	€€€	€

How does PHA compare to...

Indicator Description	PHA	Biogas
Average lifetime of product or material relative to industry average	✓	
Average % of consumed energy from renewable source	✓✓✓	✓✓✓
Percent energy recovered from residual, non-renewable resource outflows	✓	
Value per mass	€€€	€€
Investments	€€€	€€
Production costs	€€€	€
Labour	€€€	€

Conclusions

Circular performance of PHA adds value as a recovered resource from a waste stream.

Defining circular goal and indicator selection must account for stakeholders.

Unique pros and cons when compared to plastic and biogas.

Final results of regional CMA published in July 2023.



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