D4.1. Appendix No 8
Cluster of bio-based solutions classified as “small-scale technologies” (WP4, T4.2.1)

Disclaimer:

Scope: The appendix presents all the scoped solutions that were classified as “small-scale technologies”. The information on individual solutions are presented in the form of the filled – up templates. Before presenting an individual solution, information is given on the Bio4HUMAN partner responsible for scoping the given solution, as well as on the Investigation Line of T.4.2.1., the solution results from. There is also information on the presence / lack of presence of the solution on the final List of 27 bio-based products and technologies.

Note: The templates were filled up by the Leaders of Investigation Line based on the gathered information. Empty spaces in the templates mean *“no information available on the given criterion”* or *“difficulty in assessing the utility functions of the given solution”*. The second reason was quite common in relation to the potential application of the given solution to the different supply chain stages of humanitarian interventions. The filled up templates were provided to PRO CIVIS for further initial analysis. At the stage of internal consultation – all the Bio4HUMAN partners were granted access to the presentation of the solutions and were asked to provide comments and opinions on the subject of the potential applicability and functionality of the solution in the context of solid waste management in the humanitarian interventions.

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The appendix No 8 includes presentation of the following 16 bio-based solutions:

1. Black soldier fly organic waste processing system

Responsible partner: ITENE
INVESTIGATION LINE: I

Solution 1 **on the final List**	**Black soldier fly (BSF) organic waste processing system**
Product / service	
Technology	Yes
I. Basic information	
Description of functions	

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What is the effect or final product?
Black Soldier Fly to transform local organic waste into high-protein animal feed and fertilizer.
The Black Soldier Fly (BSF), *Hermetia illucens*, is recognized for its ability to convert organic waste into protein- and fat-rich feed for cattle, pigs, chicken, fish, and pets. The fly larvae are fed with organic waste, reducing its amount by 50–80%. Larvae can be harvested after about 14 days with a waste-to biomass conversion rate of up to 20% (on a total solid basis). The larvae are processed and used as animal feed, while the remaining residue can be composted and used as fertilizer (frass) and soil conditioner. The Black Soldier Fly (BSF), Hermetia illucens, is recognized for its ability to convert organic waste into protein- and fat-rich feed for cattle, pigs, chicken, fish, and pets. The fly larvae are fed with organic waste, reducing its amount by 50–80%. Larvae can be harvested after about 14 days with a waste-tobiomass conversion rate of up to 20% (on a total solid basis). The larvae are processed and used as animal feed, while the remaining residue can be composted and used as fertilizer (frass) and soil conditioner.

Description of technology and TRL level (if applicable)
The BSF organic waste processing facility consists of waste pre-processing (e.g., particle size reduction, dewatering, and inorganic waste removal), BSFL biowaste treatment, separation of BSFL from the process residue, and larvae and residue refinement into products (e.g. animal feedstuff and organic fertiliser).
TRL 9 (commercial product).

Description of product/service and TRL level (if applicable)
Product: TRL 9 (commercial product)
Service: TRL 9 (commercial product)

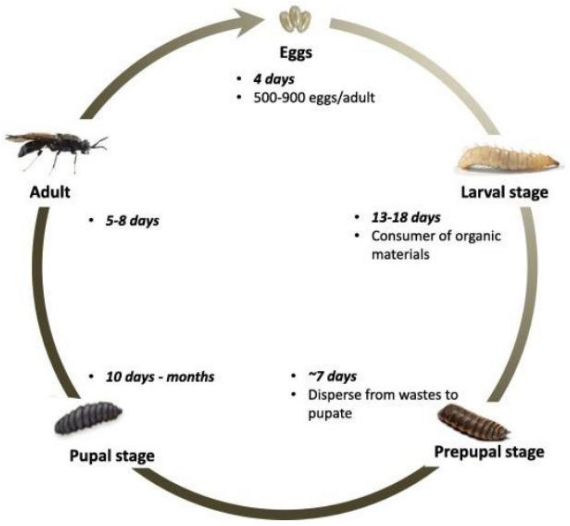
Basic conditions of use
Please include also minimum requirements of a given solution regarding the availability of public infrastructure.
Please include the optimal scale/size of investment at which their solution or technology makes economic sense.
Variable depending on the scale. The smallest units can start with few hundreds €. As suggestion for starting, mid-size of around 100,000€.
What kind of waste the solution is able to utilize or valorise?
All three - organic fractions of SWM, industrial and agri residues. In addition, it can tackle organic fraction of market waste (can be counted as SMW) and, in fact, this is very often the stream to be targeted the first.
To what extent does the use of a given solution or technology depend on climatic conditions?
Warm climate for a better and faster life-cycle of the fly and larvae, typically the best is 27-30 degrees.
BSF larvae require a warm, stable climate and thrive in temperatures between 24°C and 30°C. Consistent humidity is also crucial, with optimal levels above 60%.
Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)
Yes

Solution owner and his willingness to provide detailed technical and technological data
ACEN Foundation and EAWAG, willing to provide further information (piotr.barczak@acenfoundation.org)

Has the Life Cycle Analysis been already done for this solution?
No.

Source of data
Response to online survey on December 18th and December 20th.
https://prevent-waste.net/wp-content/uploads/2024/10/FactSheet_BUGS_PREVENT.pdf

References
Please include a description and a photo of any examples of the implementation.
As part of its activities aimed at deriving value from biowaste streams, Prevent Waste Alliance initiated a project to develop Black Soldier Fly (BSF) technology in three African countries: Uganda, Ethiopia, and Ivory Coast. This joint project is being implemented by ACEN Foundation in collaboration with other partners, including Trinomics, Eclose, and EAWAG, and is financed by GIZ as well as the Climate and Clean Air Coalition (CCAC).



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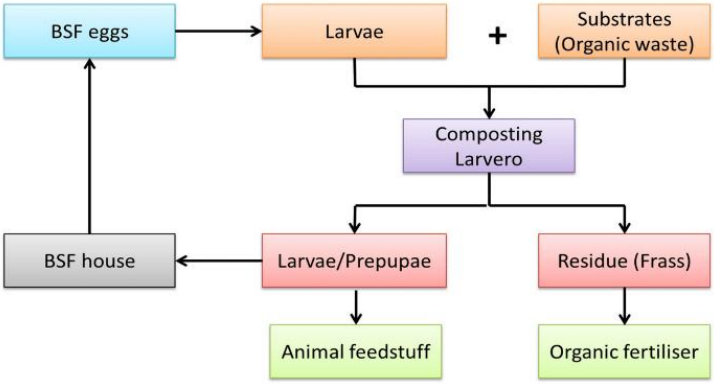

https://prevent-waste.net/wp-content/uploads/2024/10/FactSheet_BUGS_PREVENT.pdf

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.
Compostable bio-based product solution, and as a feed (larvae) for other animals.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.
Circularity of relief goods.

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IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

Besides reducing GHG emissions, the project targets food security, livelihood creation, gender and youth empowerment, and addressing environmental and waste management challenges.

Conceptualization and planning

The team is tasked with developing a guide for BSF operators and a general methodology for assessing BSF feasibility, which will be piloted, tested, and prototyped in the target countries. Another goal of the project is to capture and replicate best practices and lessons learned across African countries (Uganda, Ethiopia and Ivory Coast).

Procurement – sourcing/ purchasing of products and services

Cooperative actors enabling access to a steady, long-term supply of homogenous food- and kitchen waste is essential for larvae feeding.

Goods collection in warehouses and repacking for transport to final destination

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Custom clearance

.....

Transport to the destination country (often multi-stage and using different modes of transport)

.....

Transport to the final destinations – last mile

.....

Storage at the final destination

.....

Operational logistic at final destination - distribution of goods and services

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2. Small-Scale Residue Utilization Pathways (SSRUP) – Black soldier fly technology

Responsible partner: PRO CIVIS
INVESTIGATION LINE: IV

Solution 2 **on the final List**	**Small-Scale Residue Utilization Pathways (SSRUP) - Black Soldier Fly technology**
Product / service	-
Technology	**X**

I. Basic information

Description of functions

Small-Scale Residue Utilization Pathways (SSRUP) for High-Value Products are types of mobile integrated biorefineries.

The Small-Scale Residue Utilization Pathways for High-Value Products are a set of methods that transform organic waste into valuable products. These pathways can be defined as biorefineries when they integrate the conversion processes into a single facility. Similar to traditional refineries, biorefineries process organic waste materials instead of crude oil.

The aim is to extract maximum value from the organic waste materials, minimizing waste and maximizing productivity. These small-scale pathways are designed to be cost-effective and adaptable, and suitable for various areas, including rural and remote areas. The SSRUP offer multiple procedures, providing a range of options adaptable to the needs and capabilities of diverse sites and residuals. Through fermentation, distillation, extraction, and rearing, these mobile units provide small-scale, low-tech solutions that are easy to implement.

The SSRUP can produce a range of high-value products such as biofuels, fertilizers, animal feeds, and non-synthetic fertiliser.

The **Small-Scale Residue Utilization Pathways for High-Value Products** are all together bio-based technologies (BBT). Of particular importance for the Bio4HUMAN project is the **Black Soldier Fly**.

Description of technology and TRL level (if applicable)

In the process of finding out.

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

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Non.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.
The SSRUP are easy to implement with little effort and expenditure.

What kind of waste the solution is able to utilize or valorise?
The solutions utilise organic waste.

To what extent does the use of a given solution or technology depend on climatic conditions?
These small-scale pathways are suitable for various environments.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)
In the process of finding out.

Solution owner and his willingness to provide detailed technical and technological data

The technology was developed within the EU-funded **DIVAGRI** project (2021-2025), **'Revenue diversification pathways in Africa through bio-based and circular agricultural innovations'**, which seeks to provide African subsistence and smallholder farmers with tools to sustainably improve farm productivity, profitability and resilience through improved management of farming resources, output diversification and creation of high-value circular bioproducts.

African countries involved are: Ghana, Namibia, Mozambique, South Africa and Botswana.

There is an additional information in form of a 'fact sheet' (pdf file).

Has the Life Cycle Analysis been already done for this solution?
In the process of finding out.

Source of data

1) The web page: www.divagri.org .
2) Contact with:

   Project Manager
   Mr Sébastien CLERC-RENAUD (HSW)

   Scientific Leader
   Dr. Tiziana Centofanti (ALCN)

   Project Media Officer
   Dr Leanne Seeliger (Stellenbosch University, South Africa)

References
Please include a description and a photo of any examples of the implementation.

The Small-Scale Residue Utilization Pathways for High-Value Products are all together 7 bio-based technologies.

The most relevant for the purposes of the Bio4HUMAN project is the **Black Soldier Fly**, as it deals with converting organic waste.

The larvae of the black soldier fly (BSF) show great potential for fish production and livestock feed. A pilot study was initiated at the CSIR-Crop Research Institute

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(Ghana) to assess the practicality of cultivating BSF larvae as a supplement to conventional catfish feed. The BSF structure was constructed by laying cement blocks up to window level and then cladding it with bamboo and fibre netting and a mostly transparent roof. A "dark cage" and a "love cage" were created for breeding and egg laying. The dark cage provided low-light conditions mimicking the flies' natural habitat, while the love cage encouraged mating. Adult BSF are attracted using decomposing organic waste. BSF mate and lay eggs. Eggs hatch after 4 days and larvae are produced. The larvae are harvested and stored as feed.

Benefits:

• Converts organic waste into valuable protein, contributing to a more circular economy.
• BSF larvae provide essential nutrients, promoting faster and healthier fish growth.
• BSF larvae production yields frass as an organic fertilizer (compost) for soil improvement.

Challenges:

• Consumer acceptance of Black Soldier Fly as a source of animal feed.
• Still costly when compared with some other sources of animal feed like fish meal.
• Difficult to determine optimal larval density level.

Country Example: CSIR, Crop Research Institute, Ghana

Source: www.divagri.org

Other elements of the Small-scale Residue Utilisation Pathways (SSRUP) are inter alia mushroom production and essential oils.

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Reduction of organic waste.

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III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
1) bio - based products / services *in order to diminish the amounts of waste generated by humanitarian interventions*
2) bio - based technologies *in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

- *Please describe below how the solutions addresses the needs.*

By utilizing waste materials and turning them into valuable products, the biorefineries contribute to a more sustainable and circular economy. They help reduce waste, decrease reliance on fossil fuels, and can provide new income sources for farmers and other operators.

In a circular approach, residues and CO2 produced through the biorefinery are re-used in other DIVAGRI technologies. For example:

- insect rearing converts food wastes into chicken and aquafarm feed, providing a sustainable option for fishmeal;
- frass from insect farming is applied as a soil amendment and as fertilizer.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.

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Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc. *Please indicate the link of the supply chain for which the solution can be applied? Describe how.*
Identification of needs
.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
.....

3. Modular micro AD system – Qube Renewables

Responsible partner: IBF

INVESTIGATION LINE: III

Solution 3 **on the final List**	**modular micro AD system (Qube Renewables)**
Product / service	*Please mark X if relevant*
Technology	*X*
I. Basic information	
Description of functions *What is the effect or final product* *QUBE's first digester was designed to deal with food and sewage waste generated from their forward operating bases in Basra. As a result of this feasibility, developed a modular micro AD system which would be able to be easily transported into difficult to reach places and be run 'off grid', without the need for any supporting infrastructure.*	
Description of technology and TRL level (if applicable)	
Description of product/service and TRL level (if applicable) The modular dryQUBE solution is quick to install, taking only 2 weeks to erect.	

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Once loaded with feedstock, the dryQUBE is irrigated with liquid digestate and begins to produce biogas.

The biogas can be used for cooking, hot water, electricity generation or bioCNG vehicle fuel.

After a 60–90 day retention time, the digestate can be used as a fertiliser and the dryQUBE is refilled with a new batch of feedstock.

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.
Please include the optimal scale/size of investment at which their solution or technology makes economic sense
What kind of waste the solution is able to utilize or valorise?
To what extent does the use of a given solution or technology depend on climatic conditions?
Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

The dryQUBE is an anaerobic dry digester that provides a cost-effective solution to fibrous agricultural waste.

Batch dry digestion is suitable for high lignocellulose agricultural crops, where wet digestion and stirring of feedstock is not viable.

Possible agri-waste feedstocks for dryQUBE:

Rice

Straw Bagasse

Silage

Wheat & Rape Straw

Any other high lignocellulose agri-waste

Solution owner and his willingness to provide detailed technical and technological data

Yes, contacted and willing to talk more.

Has the Life Cycle Analysis been already done for this solution?

Implemented in other countries

Source of data

https://www.guberenewables.co.uk/dryqube,

References

Please include a description and a photo of any examples of the implementation.

The modular dryQUBE solution is quick to install, taking only 2 weeks to erect.

Once loaded with feedstock, the dryQUBE is irrigated with liquid digestate and begins to produce biogas.

The biogas can be used for cooking, hot water, electricity generation or bioCNG vehicle fuel.

After a 60–90 day retention time, the digestate can be used as a fertiliser and the dryQUBE is refilled with a new batch of feedstock.

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

.....

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*

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2) bio - based technologies *in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

It valorises agri waste and reduces food waste

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

Energy creation

Conceptualization and planning

This would require a lot of work as it will have to be delivered and erected in stages.

Procurement – sourcing/ purchasing of products and services

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Goods collection in warehouses and repacking for transport to final destination

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.....
Custom clearance
May prove difficult due to sheer size
Transport to the destination country (often multi-stage and using different modes of transport)
Boar/air/road
Transport to the final destinations – last mile
Road
Storage at the final destination
Will have to be stored somewhere with space and communal area so that it can be accessed.
Operational logistic at final destination - distribution of goods and services
Will need considerable transport in terms of trucks etc

4. Single Stage Biogas Digester

Responsible partner: PRO CIVIS

INVESTIGATION LINE: IV

Solution 4 **on the final List**	**Single Stage Biogas Digester**
Product / service	-
Technology	**X**

I. Basic information

Description of functions

The proposed **Biogas Digester** is a single-stage, solar-supported system. It operates anaerobically to break down organic wastes into usable products. The products include methane gas, water and organic fertilizer.

Description of technology and TRL level (if applicable)

In the process of finding out.

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

Non.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

In the process of finding out.

What kind of waste the solution is able to utilize or valorise?

The solution utilises organic waste.

To what extent does the use of a given solution or technology depend on climatic conditions?

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Biogas production is hindered at low temperatures (≤20°C).

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

No.

Solution owner and his willingness to provide detailed technical and technological data

The technology was developed within the EU-funded **DIVAGRI** project (2021-2025), **'Revenue diversification pathways in Africa through bio-based and circular agricultural innovations'**, which seeks to provide African subsistence and smallholder farmers with tools to sustainably improve farm productivity, profitability and resilience through improved management of farming resources, output diversification and creation of high-value circular bioproducts.

African countries involved are: Ghana, Namibia, Mozambique, South Africa and Botswana.

There is an additional information in form of a 'fact sheet' (pdf file).

Has the Life Cycle Analysis been already done for this solution?

In the process of finding out.

Source of data

- The web page: www.divagri.org .
- Contact with:

  Project Manager
  Mr Sébastien CLERC-RENAUD (HSW)

  Scientific Leader
  Dr. Tiziana Centofanti (ALCN)

  Project Media Officer
  Dr Leanne Seeliger (Stellenbosch University, South Africa)

References

Please include a description and a photo of any examples of the implementation.

This **Single Stage Biogas Digester** was developed by a team of researchers from the University of Cape Coast (UCC, Ghana) using locally available materials like stones, wood, cement, iron rods, nails, PVC pipes, copper pipes, and their accessories. The digester has a manual stirrer to mix the influent and the inoculum for better degradability.

A solar thermal heating system is installed in the digester, connected to a locally made heat exchanger – for heating the digester to a thermophilic condition of 55°C. This is done with the rationale of disinfecting the digestate for agricultural purposes since the digestate is nutrient-rich.

Benefits:

• Offers an on-site solution for managing organic waste and generating energy for farm operations.

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• Supports decentralized energy production by providing sustainable energy to local communities.

Challenges:

- Unsuitable for the management of high-risk organic waste.
- Limited local availability of the prefabricated digester.

Country Example: University of Cape Coast, Ghana

Manual excavation of the digester pit

Wood works to give the shape of the digester

Excavated pit showing the influent and effluent chambers

Solar thermal collector connected to the heat exchanger in the digester. Attached to the right is the solar water heater controller.

Source: the web page of DIVAGRI project

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Reduction of organic waste.
Recovery of energy.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;

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· *sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;*
· *utilization of local resources and knowledge.*

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

- *Please describe below how the solutions addresses the needs.*

The **Single Stage Biogas Digester** is breaking down organic wastes into usable products. The products include methane gas, water, and organic fertilizer.

The produced biogas will be converted into electricity using a combined heat and power (CHP) generator for the smallholder farmer to use at home. It could also be sold to the national grid or neighbours who may need the product.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

.....

Conceptualization and planning

.....

Procurement – sourcing/ purchasing of products and services

.....

Goods collection in warehouses and repacking for transport to final destination

.....

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Custom clearance
……
Transport to the destination country (often multi-stage and using different modes of transport)
……..
Transport to the final destinations – last mile
……
Storage at the final destination
……
Operational logistic at final destination - distribution of goods and services
……

5. Micro Biogas Digester

Responsible partner: PRO CIVIS

INVESTIGATION LINE: IV

Solution 5 **on the final List**	**Micro Biogas Digester**
Product / service	-
Technology	**X**

I. Basic information

Description of functions

Micro Biogas Digester is a small-scale physical installation that is fed with organic waste (food and agricultural / garden waste) to generate biogas energy (for cooking and heating) and to generate fertilisers.

This small-scale biogas digester can be built and implemented by any rural community.

Before installing a **Micro Biogas Digester** it is important to identify locally available energy-rich supplies of waste (household, farm, restaurant) and identify local demand for heating and cooking as well as demand for liquid fertiliser.

Micro Biogas Digester is a smart solution as it utilises reliable simple technology and minimum investment to transform waste into useful energy and fertiliser resources.

The solution demonstrates the following forms of innovation:

- **technological innovation** – it makes biogas technology available to everyone at the micro/small scale and with reliable low tech, previously reserved to larger high-tech industrial installations;
- **social innovation** – it suits neighbourly cooperation to feed and operate the digester and utilise its products, helps people understand the concept of “closing the loop”;

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- **business innovation** – it replaces seasonal farm employment with opportunities for year-round production and employment.

Description of technology and TRL level (if applicable)

The technology is already in operation.

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

Finding an appropriate site for the digester is crucial. This can be indoors or outdoors, above or below ground. Crucial aspects to consider are that the site must be able to support the weight of a large tank of water and it should support the minimisation of transport needs in terms of moving inputs and outputs.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

Construction costs are the main investment component. This includes rebar/wire mesh, cement, sand/gravel, concrete mould oil, rental of cement mixers and concrete vibrator. Other installation materials/equipment is needed to connect, filter, compress, store, test and use the biogas and grind the food. Safety signs, locks, logbooks and gas alarms are required by law.

Operating costs are mainly electricity to grind waste and pump water and compress gas.

Initial construction and installation costs: 5000 €
Ongoing/recurring annual costs: 300 €

What kind of waste the solution is able to utilize or valorise?

The solutions utilise organic waste – food, agricultural, garden.

To what extent does the use of a given solution or technology depend on climatic conditions?

The digester can run at variable flows and temperatures.

The digester temperature should be maintained at temperatures between 20-40 degrees C, which may require specific local solutions. However lower operating temperatures are also possible.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

No.

Solution owner and his willingness to provide detailed technical and technological data

Suderbyn Ecovillage, established in 2008, is an intentional community of 25 persons from 12 countries seeking to develop and test new ways of sustainable living together. NGO **RELEARN** - Suderbyn's NGO working with transformative education, research, networking of pro-change initiatives and providing employment in Suderbyn - paid for and runs the digester.

The initiative was also strongly supported by **'Solar CITIES'** - a U.S.-registered charity focused on delivering biogas solutions within the USA and across the globe.

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Has the Life Cycle Analysis been already done for this solution?
In the process of finding out.

Source of data

1) The web pages:
   https://www.smartrural21.eu/smart-solution/micro-biogas-digester/
   https://www.suderbyn.se/closed-loop.html
   https://baltcf.org/project/closed-loop-baltic-clb/

2) Contact with:

   Contact person : Robert Hall

References
Please include a description and a photo of any examples of the implementation.

The Micro Biogas Digester has been initially implemented in Suderbyn Permaculture Ecovillage, Sweden.

https://www.youtube.com/watch?v=fNGt1VG3GqY

Micro Biogas Digester mainly consists of a chamber, which is specifically designed to enable it to contain compressed air, and which can be fed (through 'feeding' pipes) with food and agricultural / garden waste and water to instigate a natural process of biodigestion generating biogas (which is collected through an 'outpipe' with gas cap).

It has a simple design that can be made locally out of easy-to-make concrete, using concrete moulds, cement mixers and concrete vibrator, irrigation rings or mortar and brick, to which feeding and run-off pipes need to be added. A steel or fiberglass gas cap with an outpipe for gas should be purchased. It has no moving parts, making it is relatively unlikely to have technical problems.

Once ready, the biodigester can be filled with water and inoculated with (microbes from) fresh cow manure. After waiting a few weeks, it is ready to be fed with organic waste and the digestion process will start naturally, producing gas.

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Source - the web page: https://www.smartrural21.eu/smart-solution/micro-biogas-digester/

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Reduction of organic waste.

The **Micro Biogas Digester** can be integrated into a full closed-loop system for the sustainable management of waste at a very localised level.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
- *ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;*
- *sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;*
- *utilization of local resources and knowledge.*

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In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

- *Please describe below how the solutions addresses the needs.*

The Micro-Biogas Digester:

- enhances hygienic disposal of organic waste products with limited local odour;
- generates valuable products in terms of fuel and fertiliser (which is also collected through a 'run-off' pipe).

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
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Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

.....

Conceptualization and planning

.....

Procurement – sourcing/ purchasing of products and services

.....

Goods collection in warehouses and repacking for transport to final destination

.....

Custom clearance

.....

Transport to the destination country (often multi-stage and using different modes of transport)

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……..
Transport to the final destinations – last mile
……..
Storage at the final destination
……..
Operational logistic at final destination - distribution of goods and services
……..

6. Domestic biogas technologies

Responsible partner: UNIVERSIDAD DE CANTABRIA
INVESTIGATION LINE: additional entry

Solution 6 **on the final List**	**Domestic biogas technologies**
Product / service	-
Technology	X

I. Basic information

Description of functions

Biogas technology is quite mature but sustainability assessment has clarify the links between the biogas energy use and the infrastructures of production.

Description of technology and TRL level (if applicable)

Comparison of 3 biogas plant designs:

Table 1
Comparison of three biogas plant designs.

Criteria	Design		
	Floating-drum	Fixed dome	Tubular type
Design principle	Continuous-feed, mixed digester	Continuous-feed, mixed digester with slurry store	Continuous-feed, fermentation channel
Main components digester/ gasholder	Masonry digester, floating metal gasholder	Masonry with displacement pit	Integrated digester/gasholder made of plastic sheeting
Preferred substrates	Fibrous and non fibrous feedstock eg., animal excrements, and or vegetable waste	Fibrous and non fibrous feedstock eg., animal excrements, and or vegetable waste	Non fibrous feedstock eg., animal excrements
Lifespan (years)[a]	12–15	15–20	2–5
Range of digester volume (V)	5–70 m^3 (domestic) 100–248 m^3 (industrial)	6–91 m^3 (domestic) 124–740 m^3 (industrial)	5–20 m^3 (domestic)
Advantages	Easy construction and operation, uniform gas pressure, mature technology	Low cost of construction, long useful life, well-insulated	Prefabricated construction, easy operation
Drawbacks[b]	Metal gasholder can rust	Sealing of gasholder, fluctuating gas pressure	In-site processing and short useful life (2-5 years) of plastic material, low gas pressure
Operation and maintenance	Simple and easy; regular painting of metal gasholder	Easy after careful familiarization	Easy; regular control of gas-pressure weights
Daily gas-output[c] (m^3 biogas/ m^3 Vd)	0.3–0.6	0.2–0.5	0.3–0.8
Cost elements	Metal gasholder, digester	Combined digester/gasholder, Excavation	HDPE plastic sheeting
Remarks	Fully developed, reliable family size system	Inexpensive equipment, good for agro residue, extensive building experience required	Suitable for fast solutions, offers possibility for recycling of plastic waste.
Installed capacity[d]	>4000 m^3	>4000 m^3	<1000 m^3

[a] Estimated useful life.
[b] All biogas plants require careful, regular inspection/monitoring of the gas-containing components.
[c] Depends on substrate composition; given values are for cattle dung (biogas potential 0.15–0.35 m^3/kg VS).
[d] Based on 2009 accounted cumulative installed capacity of 8733 m^3 [30].

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Description of product/service and TRL level (if applicable)

1) Floating drum biogas plant

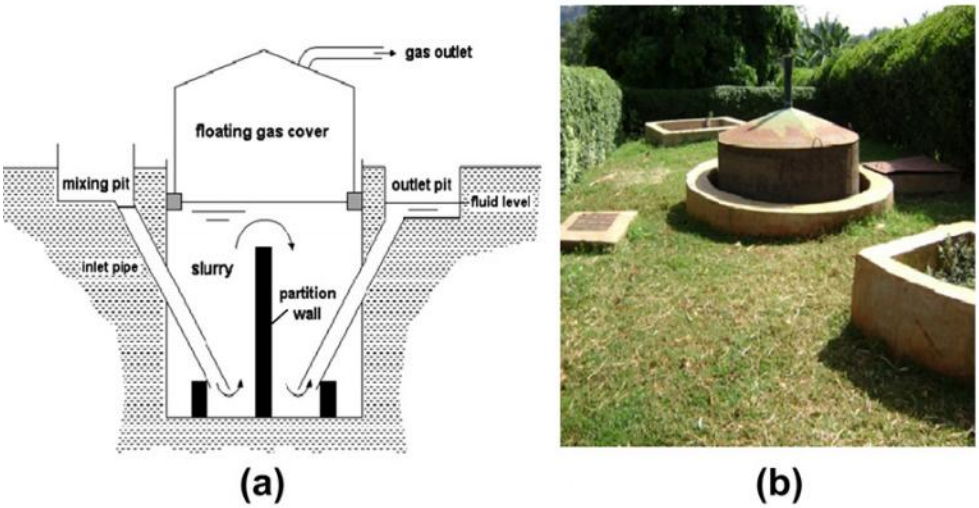

Fig. 1. Floating drum biogas digester: (a) general scheme and (b) typical plant in Kenya [30].

2) Fixed dome digester

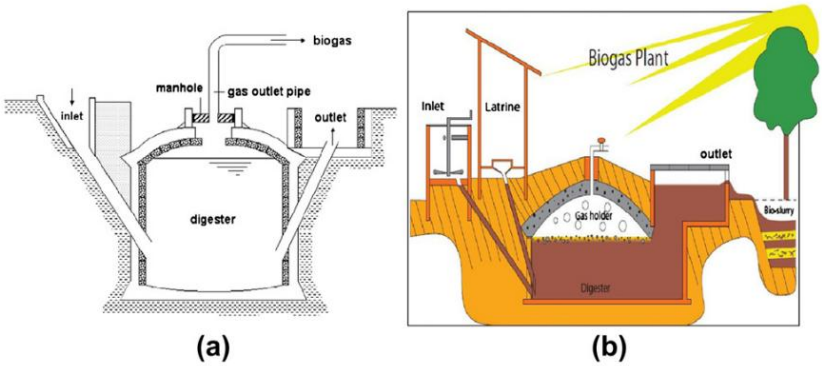

Fig. 2. Fixed dome biogas digester: (a) general scheme of a fixed dome biogas digester and (b) fixed dome digester with a coupled latrine [31].

3) Inflatable (plug flow digester)

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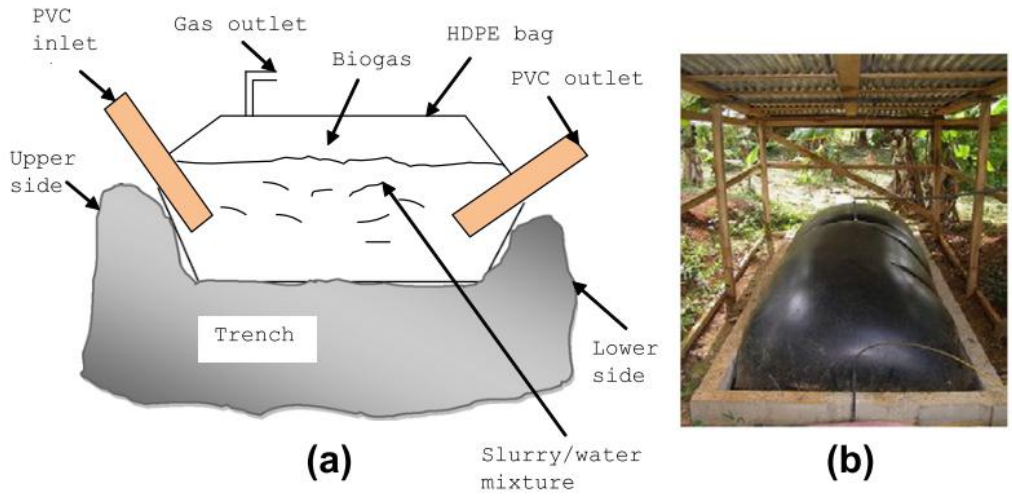

Fig. 3. Inflatable tubular digester (a) general scheme and (b) typical plant in Kenya.

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

That is the aim of the study. Linking biogas energy with infrastructures of production.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

Validated for the data inventory through construction, use and disposal phases for the 16 m^3 floating drum, fixed dome and tubular biogas digester.

What kind of waste the solution can utilize or valorise?

Fibrous and non-fibrous feedstock, including animal excrements and or vegetable waste. The small-scale tubular design may offer the possibility of recycling plastic waste.

To what extent does the use of a given solution or technology depend on climatic cconditions?

The functional unit was the production of 1 m3 biogas, operating continuously for 340 days / year for 20 years.

The digesters were located in southern, eastern and western regions of Kenya, with an average temperature between 25 and 30ºC, generally within the mesophilic range of temperatures for biogas production, so the digesters in Kenya operate without any need of external heating.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

No, needs of infrastructure but easy installation and maintenance.

Solution owner and his willingness to provide detailed technical and technological data

Ministry of Energy, A report of the national biogas survey, Department of renewavble energy, Editor, GoK: Nairobi, 2009, p. 25-40.

DBZ. Biogas and biomethane: a feasible solution for biowaste conversion into fuels and electricity in Africa, 2009.

Has the Life Cycle Analysis been already done for this solution?

Yes.

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MSCA considering environmental impacts (carbon foot print and energy requirements), technical sustainability (energy breeding ratio, energy payback and reliability) and economic sustainability impact criteria and indiators (.

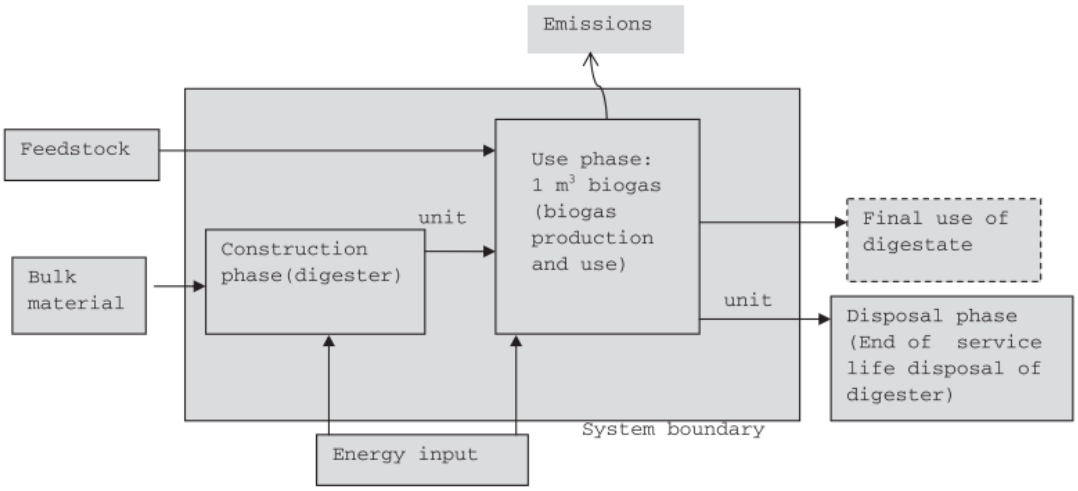

Fig. 4. Simplified scheme for MCSA of biogas production in Kenya.

Table 2
Multi criteria sustainability assessment scheme.

Dimension/Impact criteria category	Indicator	Units	Estimation method
Environmental			
• Resource depletion	Exergy equivalent	MJ/Nm^3 biogas	LCA (CEENE)
• Global warming reduction	Green House Gas (GHG) saving	kg CO_2 eq/Nm^3 biogas	LCA (IPCC 2007)
• Energy demand	Cumulative energy demand	MJ/Nm^3 biogas	LCA (CED)
Technical			
• Energy breeding ratio	Energy balance	MJ_{out}/MJ_{in}	Energy balancing
• Energy payback	Energy payback period	months	Energy accounting
• Reliability	Operational reliability	%	Non-failure rate
Economic			
• Total investment	Total capital investment cost	$ Cents/Nm^3 biogas	Cost estimation
• Energy autonomy	Fossil energy replacement saving	$ Cents/Nm^3 biogas	Energy accounting
• Labour cost	Direct labour (technology specific labour)	$ Cents/Nm^3 biogas	Direct labour accounting

Source of data
Nzila, C.; Dewulf, H.; Tuigong, D.; Kiriamiti, H.; Langehove, H. van. Applied Energy, 93 (2012) 496-506.

References
Please include a description and a photo of any examples of the implementation.

1) Floating drum biogas plant

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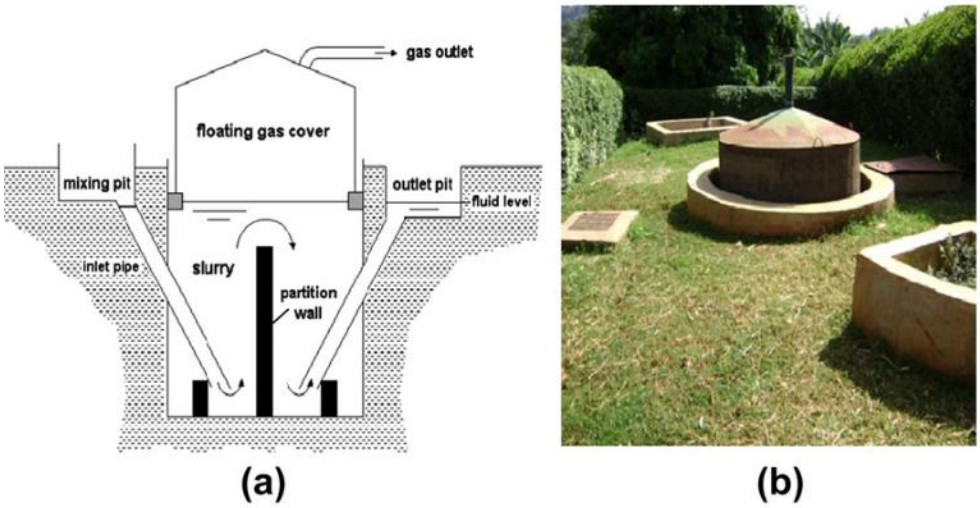

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2) Fixed dome digester

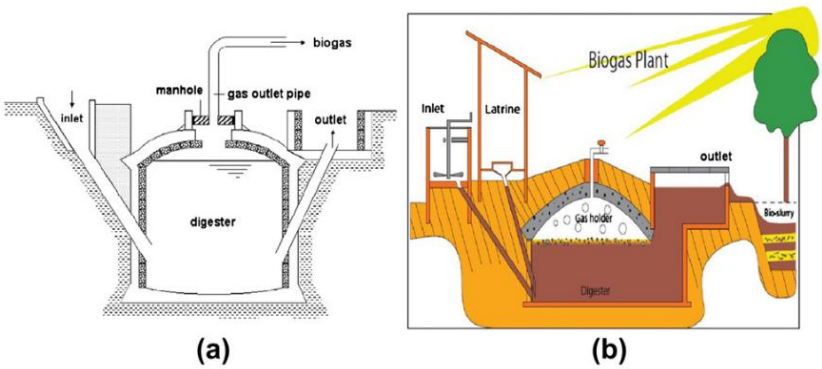

Fig. 2. Fixed dome biogas digester: (a) general scheme of a fixed dome biogas digester and (b) fixed dome digester with a coupled latrine [31].

3) Inflatable (plug flow digester)

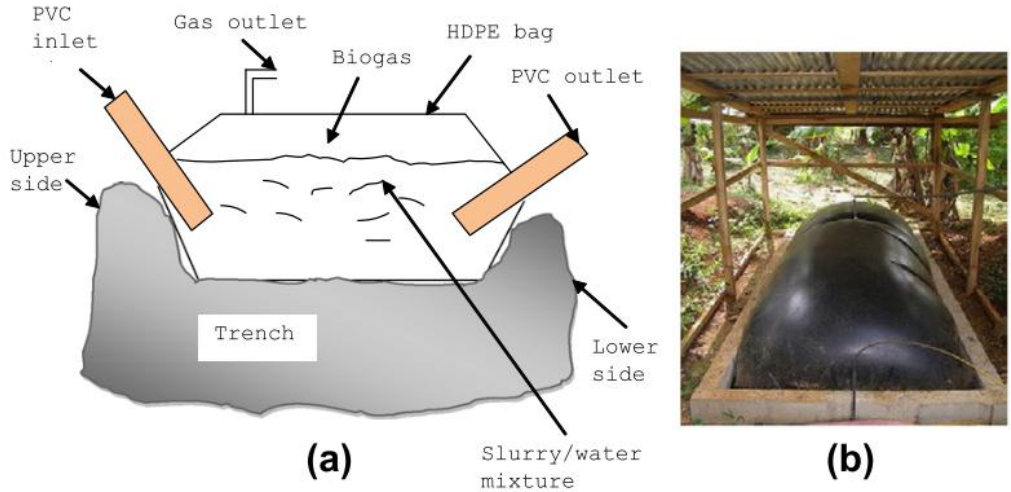

Fig. 3. Inflatable tubular digester (a) general scheme and (b) typical plant in Kenya.

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II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The excavation, bulk raw materials and transportation, energy input for fabrication and end of life service of the digesters is included in the system boundary although general fittings as well as production of digester feedstock is not considered in the analysis. Gate-to-gate.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
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***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

- *Please describe below how the solutions addresses the needs.*

The F-CUBED project offers a solution for organic residues that can be converted into energy and other valuable products. In order to treat and upgrade organic residues, a hydrothermal treatment, followed by filtration, produces a solid cake that can be pelletised for combustion and a liquid that can be used for nutrient recovery, oil and biogas production.

IV. Logistic supply chains application potential - in which stage?

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Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*
TYPICAL NON-FOOD ITEMS	
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.	
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.	
Medical supplies, wheelchairs, cold boxes.	
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).	

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Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.
Please indicate the link of the supply chain for which the solution can be applied? Describe how.
Identification of needs
Conceptualization and planning
Procurement – sourcing/ purchasing of products and services
Goods collection in warehouses and repacking for transport to final destination
Custom clearance
Transport to the destination country (often multi-stage and using different modes of transport)
Transport to the final destinations – last mile
Storage at the final destination
Operational logistic at final destination - distribution of goods and services

7. Biogas production from (bio) organic waste

Responsible partner: UNIVERSIDAD DE CANTABRIA
INVESTIGATION LINE: additional entry

Solution 7 **on the final List**	**Biogas production from (bio) organic waste**
Product / service	**X**
Technology	*X*
I. Basic information	
Description of functions *What is the effect or final product?* The effect of the final product is reducing the dependence of fossil fuel for cooking and lighting and electricity generation.	
Description of technology and TRL level (if applicable) The conventional technology is similar as that explained in Solution 1, since the biogas upgrading consist of an anaerobic digestion reactor followed or not by a cogeneration (CHP) unit:	

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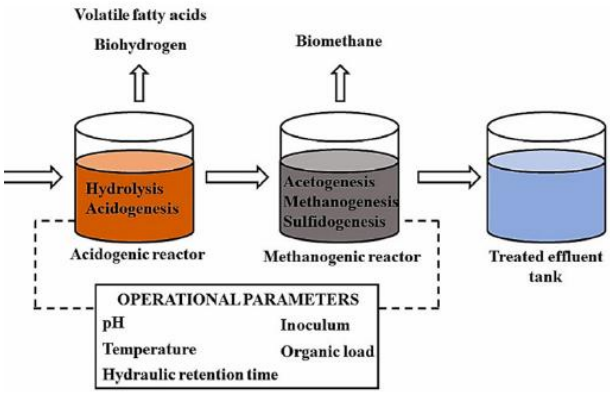

Schematic diagram for the production of biomethane/biogas and clean water from organic wastes (Gbadeyan et al. 2024).

Such biogas digesters have been applicable in different scales in different regions. The case study used as reference allude to 4-8 m^3 household digesters in rural region of Ethiopia and a larger municipal digesters to produce electricity for vehicle fuel.

Thus, TRL is 5-7. If nov

Description of product/service and TRL level (if applicable)

The integration of membrane separation processes can increase product yields and recover simultaneously from the gas stream purified biomethane with higher heating capacity and CO_2 captured that can be valorise into high added value products that could be applicable by local industries (Torre-Celeizabal et al. 2023).

If innovative solutions such as the CO2 conversion to added value products the TRL is considered 3-6, depending on the target product (Irabien et al., 2022, Rumayor et al., 2022).

Likewise, if membrane fabrication from recycled plastic waste is to be considered (Eljaddi et al. 2021) the TRL is still at TRL 3-4.

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

For the production of biogas from the organic fraction of rural or urban solid waste, as indicated in solution 1, the minimum requirements regarding public infrastructure typically include the following:
- Waste Collection and Management Systems

Utilities and Energy Supply
- Transportation and Logistics
- Industrial Zoning and Permits
- Workforce and Expertise
- Data and Monitoring Systems.

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Please include the optimal scale/size of investment at which their solution or technology makes economic sense

The optimal scale size goes from domestic households (as reference in projects in Ethiopia) to small rural or urban communities.

What kind of waste the solution is able to utilize or valorise?

The waste to be utilzed is basically food waste, fruit and cereals, grass, municipal sludge, straw, manure.

To what extent does the use of a given solution or technology depend on climatic conditions?

The solution depends on climatic conditions regarding pressure, temperature, humidity variables that may have to be monitored on site.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

Yes, the units are modulable and mobile.

Solution owner and his willingness to provide detailed technical and technological data

For example, Bright biomethane (www.bright-renewables.com) commercializes modular and compact biogas purification solutions using commercial membrane technology suitable for all kind of industries and the implementation of a CO_2 liquefaction system for recovery of this greenhouse gas before further valorization:

Source: www.bright-renewables.com

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The problem is the need to valorize the CO_2 captured and the recyclability of the membranes involved therefore the bio-based solutions presented in solution 3.

Has the Life Cycle Analysis been already done for this solution?

Yes, LCA studies have been found in literature comparing different technological approaches to improve the efficiency on energy/electricity production and waste management (GHG emissions reduction, clean water production), the application of different microorganisms to degrade the solid wastes, the introduction of novel innovative solutions at lower TRL such as the fabrication of membranes from recycled plastics or the conversion of the captured CO_2 into high added value products.

Source of data

Gabisa, E. W., & Gheewala, S. H. (2019). Potential, environmental, and socio-economic assessment of biogas production in Ethiopia: The case of Amhara regional state. Biomass and Bioenergy, 122(January), 446–456. https://doi.org/10.1016/j.biombioe.2019.02.003.

Gbadeyan, O. J., Sibiya, L., Linganiso, L. Z., & Deenadayalu, N. (2024). Waste-to-energy: the recycling and reuse of sugar industry waste for different value-added products such as bioenegy in selected countries – a critical review. Biofuels, Bioproducts and Biorefining, 18(5), 1639–1657. https://doi.org/10.1002/bbb.2579

Archana, K., Visckram, A. S., Senthil Kumar, P., Manikandan, S., Saravanan, A., & Natrayan, L. (2024). A review on recent technological breakthroughs in anaerobic digestion of organic biowaste for biogas generation: Challenges towards sustainable development goals. Fuel, 358(PB), 130298. https://doi.org/10.1016/j.fuel.2023.130298

Florio, C., Fiorentino, G., Corcelli, F., Ulgiati, S., Dumontet, S., Güsewell, J., & Eltrop, L. (2019). A life cycle assessment of biomethane production from waste feedstock through different upgrading technologies. Energies, 12(4), 718–730. https://doi.org/10.3390/en12040718

Masilela, P., & Pradhan, A. (2021). A life cycle sustainability assessment of biomethane versus biohydrogen – For application in electricity or vehicle fuel? Case studies for African context. Journal of Cleaner Production, 328(June 2020), 129567. https://doi.org/10.1016/j.jclepro.2021.129567

Torre-Celeizabal, A., Casado-Coterillo, C., Abejón, R., & Garea, A. (2023). Simultaneous production of high-quality CO2 and CH4 via multistage process using chitosan-based membranes. Separation and Purification Technology, 320(May), 124050. https://doi.org/10.1016/j.seppur.2023.124050

Irabien A., Rumayor M., Fernández-González J., Domínguez-Ramos A. Techno-economic Analysis of CO_2 Electroreduction, RSC, 2022, ch. 18, pp. 413-428. ISBN: 978-1-83916-407-1

Rumayor M., Fernández-González J., Domínguez-Ramos A., Irabien A. (2022). Deep decarbonization of the cement sector: a prospective environmental

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assessment of CO2 recycling to methanol. ACS Sustainable Chemistry and Engineering 10, 1, 267–278. https://doi.org/10.1021/acssuschemeng.1c06118

References

Please include a description and a photo of any examples of the implementation.

See above.

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Reduce, reuse, recycle.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

.....

IV. Logistic supply chains application potential - in which stage?

***The 'humanitarian supply chain'** is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*
TYPICAL NON-FOOD ITEMS	
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.	
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.	

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Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Organic solid wastes can be generated at any stage of the supply chain, but the largest amount is typically produced at the final stage to reduce emission to air, water and soil.

The consideration of the type of waste to be recycled may be influenced by the needs of the humanitarian actor and the affect the operating conditions of the solution implemented.

Identification of needs
X …
Conceptualization and planning
……
Procurement – sourcing/ purchasing of products and services
……
Goods collection in warehouses and repacking for transport to final destination
X……
Custom clearance
X……
Transport to the destination country (often multi-stage and using different modes of transport)
X……
Transport to the final destinations – last mile
X……
Storage at the final destination
X……
Operational logistic at final destination - distribution of goods and services
XX……

8. Polystyrene-consuming lesser mealworm

Responsible partner: ENSPIRE & PRO CIVIS

INVESTIGATION LINE: IV

Solution 8 **not on the final List**	**Polystyrene-consuming lesser mealworm**
Product / service	-
Technology	**X**

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I. Basic information

Description of functions

Plastic waste has recently become a major global environmental concern and one of the biggest
challenges has been seeking for alternative management options. Several studies have revealed
the potential of several coleopteran species to degrade plastics.

One of the most promising species in terms of the plastic – degradation potential are **lesser mealworms from Africa,** which shows the ability to consume polystyrene (PS).

Polystyrene waste results from the commercial use of its common form, Styrofoam, which is used for various applications including food storage containers, packaging of equipment, disposable plates and cups, and insulation in construction.

In the conducted study it has been shown, that:

1. **the lesser mealworms** are able to chew, burrow and successfully feed on the blocks of Styrofoam;
2. during the PS feeding trials, PS intake was observed to increase over a 30-day period, while overall survival rates of the larvae decreased when fed a sole PS diet;
3. the predominant bacteria observed in larvae fed PS diets were *Kluyvera*, *Lactococcus*, *Klebsiella*, *Enterobacter*, and *Enterococcus*, while *Stenotrophomonas* dominated the control diet.

The study findings demonstrate that the newly identified **lesser mealworm** can survive on a PS diet and has a consortium of important bacteria strongly associated with PS degradation.

Description of technology and TRL level (if applicable)

TRL2-TRL3

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

Non.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

Data not available at this stage.

What kind of waste the solution is able to utilize or valorise?

The solution utilises plastic waste – Styrofoam.

To what extent does the use of a given solution or technology depend on climatic conditions?

In the process of finding out.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

Data not available at this stage.

Solution owner and his willingness to provide detailed technical and technological data

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The study has been coordinated by the International Centre of Insect Physiology and Ecology in Nairobi, Kenya.

There is an additional material in form of an article *'Mitogenomic profiling and gut microbial analysis of the newly identified polystyrene-consuming lesser mealworm in Kenya'* (pdf file).

Has the Life Cycle Analysis been already done for this solution?

No.

Source of data

- The scientific report published in Nature on September 12th, 2024 entitled *"Mitogenomic profiling and gut microbial analysis of the newly identified polystyrene-consuming lesser mealworm in Kenya"*.
- Contact with one of the 4 co –authors:

  Dr. Fathiya M. Khamis

References

Please include a description and a photo of any examples of the implementation.

The initial study has been conducted in Kenya.

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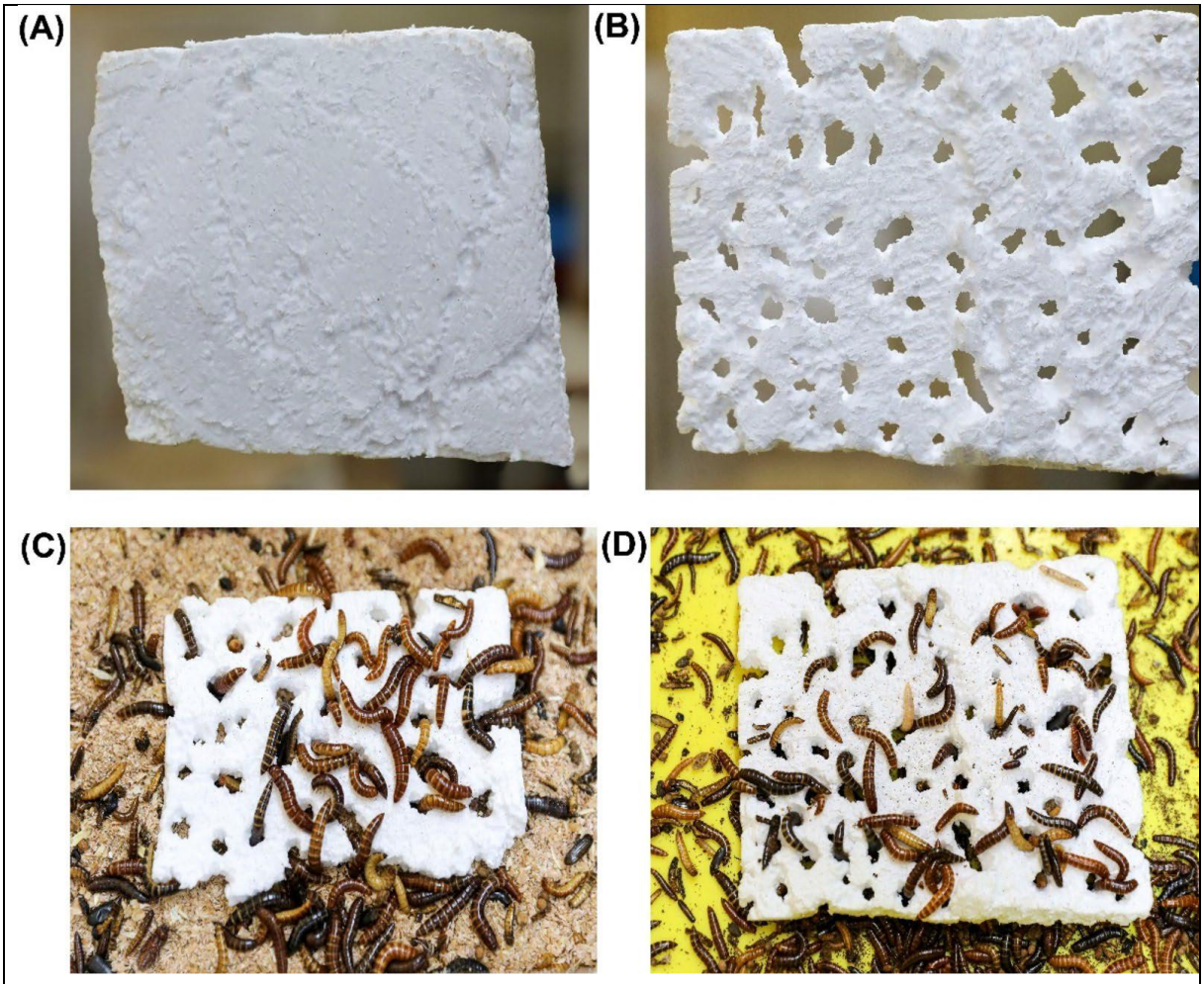

(A) Styrofoam block before feeding
(B) Styrofoam block after 30 day feeding and consumption of the polystyrene (PS) evident by the holes and tunnels formed
(C) mealworms feeding on polystyrene and bran diet
(D) mealworms feeding on sole Polystyrene diet

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Reduction of plastic waste.
To be confirmed in the further studies – the possibility of becoming high-value insect protein-rich biomass for animal feeds as the outcome of the process.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:

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· *ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;*
· *sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;*
· *utilization of local resources and knowledge.*

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

- *Please describe below how the solutions addresses the needs.*

The mealworms have the ability to degrade PS with approximately 47.7% of the Styrofoam ingested and converted into carbon dioxide while the residue was excreted as frass.

The conducted study work provides a better understanding of bioremediation applications and brings hope to solving plastic waste pollution while providing high-value insect protein towards a circular economy.

While the diverse capabilities of **lesser mealworms** offer promising possibilities in developing sustainable waste management strategies, challenges such as optimization, scaling up for practical application and ensuring the safety of the end products needs to be addressed. Additionally, the efficacy of the **lesser mealworm** in degrading different types of plastics and the potential impacts on their health and behaviour requires further investigation as well as their ability to convert waste into high-value insect protein-rich biomass for animal feeds. Continued research and collaborative efforts between scientists, policymakers, and industries will be instrumental in realizing the full potential of **lesser mealworms** and other similar organisms. These combined efforts hold the key to addressing plastic waste while providing high-value insect protein towards fostering a circular economy framework.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*
TYPICAL NON-FOOD ITEMS	
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.	
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.	
Medical supplies, wheelchairs, cold boxes.	

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Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs
.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
.....

9. ROBONOVA® - the bioremediation technology

Responsible partner: PRO CIVIS

INVESTIGATION LINE: IV

Solution 9 **not on the final List**	**ROBONOVA®** - the bioremediation technology
Product / service	-
Technology	**X**

I. Basic information

Description of functions

ROBONOVA® is a piloting system that models an on-site (on the reclamation site) ex-situ (treatment on a matrix removed from its natural site) bioremediation technology, which exploits oxidative-aerobic processes operated by

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microorganisms in the matrix to be treated (soil, sediment), using the organic contaminant as a source of carbon and energy.

These processes result in the removal of organic contaminants by mineralization and partial oxidation, favoring the humification of the matrix and restoring an ecologically active techno-soil.

The **ROBONOVA®** system is equipped with:

- Bioreactor for the growth of microbial cultures.
- Completely automated pile turning machine, used for tilling, irrigation, conditioning and biostimulation of the soil matrix (2 m3).
- 50 L water tank and storage compartments for soil amendments.
- Instrumentation for the inoculation of microbial cultures selected for the biodegradation activity.
- Emissions monitoring and treatment system (GAC filter).
- Leachate collection, monitoring and treatment unit.

ROBONOVA® 2.0, implemented in a 40"industrial container, can also be requested with further equipment for testing of soil parameters and for biomass production and monitoring. The additional items of the Soil Testing Facility (STF) can include a compact microbiology lab for the preparation and testing of the microbial inoculant, multiparameter probes for soil and workspace for amendments and surfactants formulation.

Being fully automated and deliverable on site, ready to go, it represents a bridge between laboratory scale and full scale for bioremediation projects.

Description of technology and TRL level (if applicable)

TRL 8 – 9. The technology has been successfully deployed in a complex project in Kuwait

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

No special requirements as for the availability of public infrastructure.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

No data available at this stage of investigation.

What kind of waste the solution is able to utilize or valorise?

The solution could be used for the purposes of the bioremediation processes, i.e. microorganisms or plants used to break down contaminants in soil affected by improper waste disposal.
The bioremediation has been pointed out by the Bio4HUMAN humanitarian partners (PIN, PAH) as one of the bio – based solutions welcomed by many in the humanitarian sector.

To what extent does the use of a given solution or technology depend on climatic conditions?

There is no dependency on climatic conditions.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

Yes.

Solution owner and his willingness to provide detailed technical and technological data

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DND BIOTECH, Italy
The Solution owner is open for further exchange of information.

Has the Life Cycle Analysis been already done for this solution?
Due to the budgetary constraints the LCA has not been so far performed.

Source of data

- The Company's presentation at the ECOMONDO 2024 in Rimini.
- Mail correspondence with CEO of DND BIOTECH – Cosimo Masini.
- The web page: https://www.dndbiotech.it

References
Please include a description and a photo of any examples of the implementation.

Photographs, incl. illustrative movie available at:
https://www.dndbiotech.it/robonova/?lang=en

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The solution refers to the remediation processes.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

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Please describe below how the solutions addresses the needs.

The solution allows for:

- the remediation of contaminated soil
- the production of biomass

Selected benefits from using the ROBONOVA® system:

- Continuous monitoring of both the metabolic activity of microorganisms and the processes of remediation, validating the results of the protocols and processes developed on a laboratory scale, towards large-scale bioremediation works.
- Continuous monitoring of energy and water consumption, leachate, and liquid waste.
- Continuous, detailed, and reliable monitoring of gas (CO2, O2, CH4, VOC) and micro dust emissions deriving from bioremediation activities, compared to the weekly / monthly survey activities in the test and field areas.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

.....

Conceptualization and planning

.....

Procurement – sourcing/ purchasing of products and services

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.....
Goods collection in warehouses and repacking for transport to final destination
Potential for the contamination of the soil due to improper waste disposal.
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
Potential for the contamination of the soil due to improper waste disposal.
Operational logistic at final destination - distribution of goods and services
Potential for the contamination of the soil due to improper waste disposal.

10. Household Composter

Responsible partner: PRO CIVIS
INVESTIGATION LINE: IV

Solution 10 **not on the final List**	**Household Composter**
Product / service	-
Technology	**X**

I. Basic information

Description of functions

The **Household Composter** – home composting machine is an electric composting unit ideal for small-scale waste generators like homes, schools, offices. The household composting machine utilizes microbes to compost food waste in 24 hours, producing a nutrient-rich soil amendment that can be used in gardens.

The composters: 1) work automatically and process organic waste easily; 2) provide odorless and safe handling; 3) allow for the reduction of the emissions of methane gas.

Description of technology and TRL level (if applicable)
TRL 9 – technology launched and in operations.

Description of product/service and TRL level (if applicable)
-

Basic conditions of use
Please include also minimum requirements of a given solution regarding the availability of public infrastructure.
No additional requirements.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.
No data available at this stage of investigation.

What kind of waste the solution is able to utilize or valorise?
The solution could be used for the purposes of disposing the organic / food waste.

To what extent does the use of a given solution or technology depend on climatic conditions?

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No dependency.
As the microbes thrive on the combination of oxygen, heat, and new food waste the temperature of the process should be kept between 45℃ to 70℃.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)
Yes.

Solution owner and his willingness to provide detailed technical and technological data
TOGO Environment Equipment, China
The Solution owner is open for further exchange of information.

Has the Life Cycle Analysis been already done for this solution?
No, it has not.
There is only information provided, that the service life of the machine is 10-15 years.

Source of data

- The Company's presentation at the IFAT 2024 in Munich.
- Mail correspondence with Ivy Lee – the Sales Representative.
- The web page: togohb.com

References
Please include a description and a photo of any examples of the implementation.

Photographs available at: https://togohb.com/products/



TG-CC-5 TG-CC-100 TG-CC-1000 .....

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The solution refers to the reduction of organic / food waste and allows for the transformation of kitchen waste and food scraps into 100 % organic ready-to-use compost for indoor or outdoor plants, gardens, and backyards.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;

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· *utilization of local resources and knowledge.*

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

The solution allows for reduction of waste and for providing an eco-friendly solution for leftovers.

The by – products could be used to fertilize the plants, make animal feed and a burnable bio – fuel.

The use of the technology reduces methan and CO2 emission.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

……

Conceptualization and planning

……

Procurement – sourcing/ purchasing of products and services

……

Goods collection in warehouses and repacking for transport to final destination

……

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Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
Reduction of organic / food waste, being the result of distributed goods and services.

11. Mobile composting system for use in closed area for treatment of waste

Responsible partner: ITENE
INVESTIGATION LINE: V

Solution 11 **not on the final List**	**Mobile composting system for use in closed area for treatment of waste**
Product / service	
Technology	**X**

I. Basic information

Description of functions

What is the effect or final product?

An equipment designed to carry out composting in an enclosed space, or at least the initial, more biologically active phases of the composting process.

Description of technology and TRL level (if applicable)

It consists of a closed, towable compartment in which environmental conditions favourable to composting can be created and maintained. Said enclosed space will be made of corrosion-protected metal or synthetic material. This technology is intended to enable the treatment of waste by composting using an innovative system and is applicable to companies that generate waste that can be composted, but whose composting must be carried out in a closed space. This situation applies to agricultural companies where there is a need to dispose of animal carcasses that have died of natural causes or diseases, but it can also be used to treat problematic organic waste from other types of companies, both continuous and discontinuous.

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No information about TRL is provided, but it is estimated a TRL of 7.

Description of product/service and TRL level (if applicable)

Not applicable.

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

This technology requires specific equipment.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense

This solution is expected to be cheaper than current closed system solutions thanks to its mobility.

What kind of waste the solution is able to utilize or valorise?

Agricultural waste mainly (preferably dried fruits), but also animal corpses from the agricultural industry may be valorised.

To what extent does the use of a given solution or technology depend on climatic conditions?

Not relevant.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

Yes. In fact, the solution is considered as such.....

Solution owner and his willingness to provide detailed technical and technological data

UNIVERSIDADE DO ALGARVE

Has the Life Cycle Analysis been already done for this solution?

No information provided.

Source of data

Derwent Innovation patent search.

References

Please include a description and a photo of any examples of the implementation.

Layout of the process:

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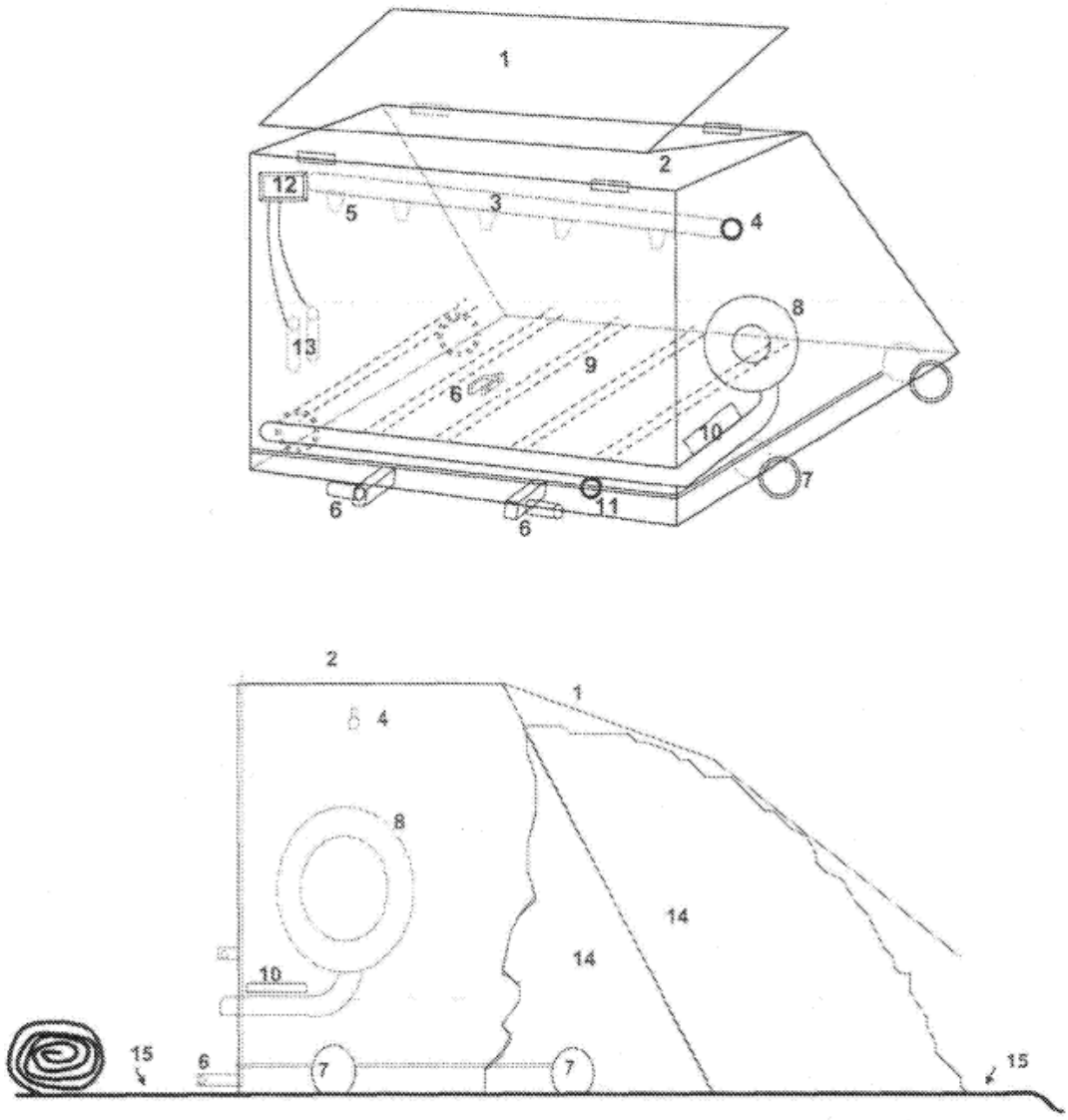

Source: *Derwent Innovation patent search.*

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Compostability.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:

***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*

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2) bio - based technologies *in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:

· *ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;*

· *sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;*

· *utilization of local resources and knowledge.*

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

The solution addresses sustainability needs as it allows the compostability of organic waste in a mobile space.

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*
TYPICAL NON-FOOD ITEMS	
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.	
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.	
Medical supplies, wheelchairs, cold boxes.	
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).	
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.	
Paper, printed products, office equipment, electronic waste, etc.	

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Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.
Please indicate the link of the supply chain for which the solution can be applied? Describe how.
Identification of needs
.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
.....

12. HBI TECHNOLOGY (Polygenerative Integrated System)

Responsible partner: PRO CIVIS
INVESTIGATION LINE: IV

Solution 12 **not on the final List**	**HBI TECHNOLOGY (Polygenerative Integrated System)**

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Product / service	-
Technology	**X**

I. Basic information

Description of functions

Through a specific and proprietary molecular separation process, the **HBI TECHNOLOGY** can extract high-value sustainable materials such as ammonia, hydrogen and nutrients for agriculture from sludge, which constitutes **the semi – solid type of waste**. At the same time, clean and renewable energy is produced, making the plant completely energy self-sufficient.

The **HBI TECHNOLOGY** integrates two innovative processes: hydrothermal carbonization (HTC) and gasification.

The **HBI TECHNOLOGY** is modular and scalable to ensure small – and large-scale applications. The process is a tangible example of a circular system and sustainable recycling of resources that, unfortunately, are still largely destined for landfill or incineration.

The application of **HBI TECHNOLOGY**, which emits no odors or gases, reduces sewage sludge management operating costs by at least 15 percent through:

- a volume reduction of up to 90%;
- the recovery of high value-added materials (such as ammonia and nutrients for agriculture);
- self-sufficiency of the plant from the energy point of view;
- the recovery of the water contained in the sludge of up to 85%.

When applied to digested sludge, the technology can increase biogas production by up to +40%.

Description of technology and TRL level (if applicable)

In the process of finding out.

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

In the process of finding out.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

No data available at this stage of investigation.

What kind of waste the solution is able to utilize or valorise?

The solution could be used for the purposes of valorising sewage sludge, by enabling the sustainable recovery of clean energy and high-value materials. The **HBI TECHNOLOGY** reduces the final volume of sewage sludge due for disposal by more than 90 percent. The technology can directly treat sewage sludge and digestates.

To what extent does the use of a given solution or technology depend on climatic conditions?

In the process of finding out.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

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In the process of finding out.

Solution owner and his willingness to provide detailed technical and technological data

HBI Srl, Italy

The Solution owner was initially open for further exchange of information.

Has the Life Cycle Analysis been already done for this solution?

In the process of finding out.

Source of data

- The Company's presentation at the ECOMONDO 2024 in Rimini.
- Mail correspondence with CEO of HBI Srl – Daniele Basso.
- The web page: www.hbigroup.it

References

Please include a description and a photo of any examples of the implementation.

Source: the web page of HBI Srl

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The solution refers to:

1) the reduction of semi – solid waste in the form of sludge;
2) the recovery from sludge of high-value sustainable materials for agriculture such as ammonia, hydrogen and nutrients.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

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We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

The solution allows for:

- treating sewage sludge in a circular manner by minimizing its volume output;
- extracting secondary critical raw materials;
- producing renewable energy.

The technology recovers more than 90 percent of the materials and energy contained in the sludge.

IV. Logistic supply chains application potential - in which stage?

***The 'humanitarian supply chain'** is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*
TYPICAL NON-FOOD ITEMS	
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.	
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.	
Medical supplies, wheelchairs, cold boxes.	
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).	
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.	
Paper, printed products, office equipment, electronic waste, etc.	
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.	

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs

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.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
.....

13. WasteMaster - "The Ultimate Food and Organic Waste Repurposing Technology"

Responsible partner: PRO CIVIS

INVESTIGATION LINE: IV

Solution 13 **not on the final List**	**WasteMaster** - "The Ultimate Food and Organic Waste Repurposing Technology"
Product / service	-
Technology	**X**

I. Basic information

Description of functions

Green Eco Technologies' **WasteMaster** system uses unique technology to convert food waste, without bacteria, other additives, or water, into a virtually odour-free, much reduced quantity of reusable residual material.

The **WasteMaster's** innovative technology blasts the cell walls of the food waste with charged oxygen molecules, which accelerate decomposition. The moisture in the waste is evaporated and vented into the air as humid, odour-free vapour. What remains is **a pathogen-free, high-calorific value, nutrient-rich residue**, which is ideal **for a range of beneficial uses**.

At the end of the process the weight of the organic waste has been reduced by up to 80 %. For every 500kg loaded into the system, **WasteMaster** outputs around

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100kg of **compost-like residual material, which will not attract insects or vermin in its dry state**.

Harnessing the proprietary technology, the **WasteMaster** can reduce the weight of food waste loaded by up to 80% in a short time, usually between 10 – 24 hours, while retaining the calorific and nutrient value of the waste loaded. It must be noted that in comparison to the **WasteMaster** technology:

- the composting of food waste takes considerably longer, erodes the calorific and nutrient value of the waste loaded, and releases considerably more CO2 eq greenhouse gases than the **WasteMaster**;
- the dehydrators use extreme temperatures to 'cook' the waste; this process requires large amounts of power and unlike the **WasteMaster** destroys the nutrient and calorific value of the waste in the process.

WasteMaster can be programmed in batch loading or continual loading modes, depending on which best fits with the current processes. This means the organic waste could be loaded whenever the process requires it. The total amount of the load depends on the size of the given **WasteMaster** system.

The whole process is controlled by **WasteMaster's** management software. The operator pushes the full bin of food waste into the bin lifter and presses the start button, leaving the **WasteMaster** to do the work and even unload the residue automatically when processing is complete. The diagnostic and remote monitoring functions make food waste conversion a 'set and forget' operation, providing a window on real-time processing, with integrated data capture also supporting accurate environmental reporting.

Description of technology and TRL level (if applicable)

TRL 9

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

No special requirements as for the availability of public infrastructure.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

No data available at this stage of investigation.

What kind of waste the solution is able to utilize or valorise?

Food / Organic waste.

To what extent does the use of a given solution or technology depend on climatic conditions?

There is no dependency on climatic conditions.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

Yes.

Solution owner and his willingness to provide detailed technical and technological data

Green Eco Technologies

The Solution owner is open for further exchange of information.

Has the Life Cycle Analysis been already done for this solution?

Yes, it has.

Source of data

- The Company's presentation at the IFAT 2024 in Munich.
- Mail correspondence with Katie Young, Commercial Director

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- The web page: https://www.greenecotec.com/

References

Please include a description and a photo of any examples of the implementation.

Examples of implementation available at: https://www.greenecotec.com/successstories
Photographs, incl. illustrative movie available at: https://www.greenecotec.com/how-it-works

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II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The solution allows for:

- the reduction of organic waste
- the potential reuse of a pathogen-free, high-calorific value, nutrient-rich residue

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Funded by the European Union

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Please describe below how the solutions addresses the needs.

As proven above - the solution allows for the elimination of organic humanitarian waste and exercises sustainability features, especially in terms of environmental factors.

Selected environmental benefits from using the WasteMaster system:

- minimisation of the requirements for use of offsite composters
- clean and sustainable way to cut down on landfill disposals
- reduction of the transport of organics to off-site locations
- reduction of carbon emissions
- removal of issues of skip bin odour and vermin

IV. Logistic supply chains application potential - in which stage?

The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs
.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....

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Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
As the presented solution deals with the organic waste – this is the stage of the humanitarian supply chain the solution can be applied for.

14. Bio-flocculants for water utilities

Responsible partner: IBF

INVESTIGATION LINE: III

Solution 14 **not on the final List**	**bio-flocculants for water utilities**
Product / service	*X*
Technology	*X*

I. Basic information

Description of functions
What is the effect or final product?
Flocculation is the separation of a solution, commonly the removal of sediment from a fluid. The term is derived from floc, which means flakes of material; and when a solution has been flocculated, the sediment has formed into larger aggregated flakes, making them easier to see and remove. This process occurs naturally, or it can also be forced using flocculants and/or physical processes.

Description of technology and TRL level (if applicable)
.....

Description of product/service and TRL level (if applicable)
Flocculation is the separation of a solution, commonly the removal of sediment from a fluid. The term is derived from floc, which means flakes of material; and when a solution has been flocculated, the sediment has formed into larger aggregated flakes, making them easier to see and remove. This process occurs naturally, or it can also be forced using flocculants and/or physical processes. Superfloc® BioMB products are based on chemistry that's technically equivalent to polyacrylamide, a solution that reliably cleans wastewater around the world. Plus, they are hassle-free; wastewater utilities can implement them even without trials, new equipment or process changes.

Basic conditions of use
Please include also minimum requirements of a given solution regarding the availability of public infrastructure.
Please include the optimal scale/size of investment at which their solution or technology makes economic sense
What kind of waste the solution is able to utilize or valorise?
To what extent does the use of a given solution or technology depend on climatic conditions?
Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

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Solution owner and his willingness to provide detailed technical and technological data

Kemira, contacted but no response

Has the Life Cycle Analysis been already done for this solution?

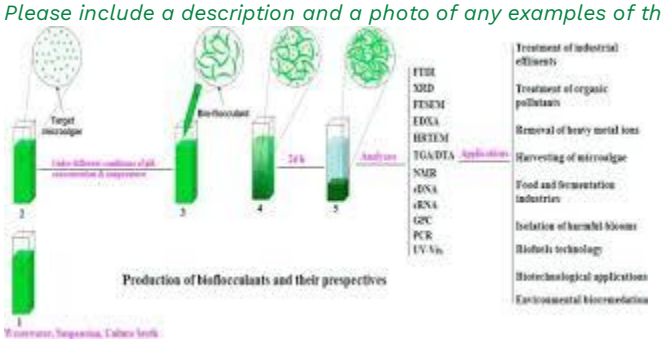
N/A

Source of data

https://www.kemira.com/stories/new-bio-flocculants-for-water-utilities/, **mikko.pohjala@kemira.com**

References

Please include a description and a photo of any examples of the implementation.



New Superfloc® BioMB, the world's first line of biomass balanced flocculants, These flocculants are drop-in solutions. Superfloc® BioMB mixes standard raw materials with 50% or more biobased raw materials. As a result, the overall raw material quality remains the same, as does the performance of the final product. It's what's known as a mass-balanced approach to biobased chemistry.

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

.....

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

Reduces the need to look at fossil-based water treatment chemistries made from polyacrylamides.

IV. Logistic supply chains application potential - in which stage?

***The 'humanitarian supply chain'** is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

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Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs
Water treatment
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
Air and road
Transport to the final destinations – last mile
Via road transport
Storage at the final destination
N/A
Operational logistic at final destination - distribution of goods and services
This will be conducted by specialised staff in water quality and hygiene settings.

15. NENU2PHAR - PHA stream to create a competitive value chain of bioplastic material for high-volume consumer products

Responsible partner: AIMPLAS

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INVESTIGATION LINE: II

Solution 15 **not on the final List**	**NENU2PHAR**
Product / service	
Technology	

I. Basic information

Description of functions
What is the effect or final product?

Develop a PHA stream to create a competitive value chain of bioplastic material for high-volume consumer products, manufactured with a purely biotechnological route, with a variety of carbon-rich biomass feedstocks.

.....

Description of technology and TRL level (if applicable)

Production of the carbon feedstock from algae biomass at pilot scale. TRL 4.
Extraction of PHA biopolymer at pilot scale. TRL 4.

.....

Description of product/service and TRL level (if applicable)

PHA bio-based bio-plastics products (food packaging, cosmetic packaging, agrotextile, 3D printing filament, medical device) from a sustainable resource with sustainable end of life options. TRL 3-4.

.....

Basic conditions of use
Please include also minimum requirements of a given solution regarding the availability of public infrastructure. Please include the optimal scale/size of investment at which their solution or technology makes economic sense

Changing fossil-based plastic products to PHA-based products is the main goal of the project, so, the principal requirement is that the humanitarian supply chain leaders should consider the use of the new bio-based products from the beginning.

The size of investment should be high enough to ensure the development of the scalable technology implementation, in the final destination of the supply chain or in another part despite of the logistics.

What kind of waste the solution is able to utilize or valorise?

By mechanical recycling, PHA products are sorted and subjected to different pre-treatments to obtain recycled pellets.

To what extent does the use of a given solution or technology depend on climatic conditions?

The technology is not affected by climatic conditions.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

It is possible to refine the solution as an autonomous and mobile unit but it depends on microalgae as feedstock so the location of the plant is crucial.

.....

Solution owner and his willingness to provide detailed technical and technological data

Data provided by scientific articles and press releases & leaflets published on the project website https://nenu2phar.eu/public-documents/#scientific-articles.

Any progress done is registered on the website.

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.....

Has the Life Cycle Analysis been already done for this solution?

WP7. The Life Cycle Assessment is not finished yet, but the main goal is to develop more sustainable products than fossil-based products. No more information found.

.....

Source of data

https://nenu2phar.eu/

.....

References

Please include a description and a photo of any examples of the implementation.

https://nenu2phar.eu/ (video explaining the project and the processes followed).

.....

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

Mechanical recycling to produce recycled pellets.

Composting.

.....

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

With PHA-biobased products the supply chain becomes circular because the waste generated can be recycled or composted for re-manufacturing.

PHA-based products have less environmental impact than traditional plastics, and the objective is to make them suitable to substitute high-volume consumer products, also reducing the amount of waste generated.

.....

IV. Logistic supply chains application potential - in which stage?

***The 'humanitarian supply chain'** is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

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COMMODITY TYPE	PACKAGING
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs
Study the possibility to move from traditional plastic products used in supply chains, to PHA-based products manufactured from eco-design. ……
Conceptualization and planning
-
Procurement – sourcing/ purchasing of products and services
Planning the transition to PHA products. - Food packaging: flat film further thermoformed, stand up pouch for dry food and plastic cup. - Medical Device: biodegradability, biocompatibility, and optimal mechanical properties. ……
Goods collection in warehouses and repacking for transport to final destination
……
Custom clearance
……
Transport to the destination country (often multi-stage and using different modes of transport)
……
Transport to the final destinations – last mile
……
Storage at the final destination
……
Operational logistic at final destination - distribution of goods and services
Reducing the amount of waste generated at the end of the supply chain. ……

16. Zeolite Technology

Responsible partner: PRO CIVIS

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INVESTIGATION LINE: IV

Solution 16 **not on the final List**	**Zeolite Technology**
Product / service	-
Technology	**X**

I. Basic information

Description of functions

The **Zeolite Technology** has been presented as bio-based in nature and with relevant application to solid waste management in humanitarian contexts. Specifically:

- **Composting Amendment –** Zeolite can be used as an amendment to accelerate and improve the composting of organic waste, a significant waste stream in many humanitarian settings. This application not only reduces landfill waste but also produces valuable compost that could support local agriculture, therefore aligning with Bio4HUMAN's interest in bio-based and circular solutions.
- **Soil Quality Enhancement –** In areas facing long-term crises, where sustainable agriculture is essential, Zeolite has proven effective in enhancing soil quality, helping to stabilize food production systems.

Description of technology and TRL level (if applicable)

TRL 8 – 9.

Description of product/service and TRL level (if applicable)

-

Basic conditions of use

Please include also minimum requirements of a given solution regarding the availability of public infrastructure.

No.

Please include the optimal scale/size of investment at which their solution or technology makes economic sense.

No data available at this stage of investigation.

What kind of waste the solution is able to utilize or valorise?

The solution could be used for the purposes of valorising organic waste.

To what extent does the use of a given solution or technology depend on climatic conditions?

It does not.

Is it possible to refine the solution as an autonomous and mobile unit? (if applicable)

In the process of finding out.

Solution owner and his willingness to provide detailed technical and technological data

ZEOCEL ITALIA

The Solution owner seems open for further exchange of information.

Has the Life Cycle Analysis been already done for this solution?

No.

Source of data

- The Company's presentation at the ECOMONDO 2024 in Rimini.
- Mail correspondence with CEO of ZEOCEL ITALIA – Cosimo Masini.

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- The web page: https://zeocelitalia.it

References

Please include a description and a photo of any examples of the implementation.

Source: https://zeocelitalia.it

II. End-of-life stage addressed by the solution

Please describe if the solution refers to 4R Principle (Reduce, reuse, recycle, recover) biodegradability, composability or other means of end-of-life stage.

The solution refers to the reduction of organic waste.
There are also examples of recovery of the organic fraction from municipal solid waste from households – joint project with NGO in Senegal.

III. Needs of the humanitarian sector and / or of the solid waste management constraints in the humanitarian settings addressed by identified solution

We are looking for:
***1) bio - based products / services** in order to diminish the amounts of waste generated by humanitarian interventions*
***2) bio - based technologies** in order to cope with the amounts of waste generated in the humanitarian context.*

The expected characteristics of the bio-based solutions potentially applicable in the humanitarian context:
· ability to eliminate the humanitarian waste, i.e. plastic, aluminium, metal, glass, paper & cardboard, organic, wood, medical and chemical;
· sustainability – addressing environmental, economic, and social factors; be adaptable to local conditions; provide long-term benefits without unintended negative consequences;
· utilization of local resources and knowledge.

In case of a doubt as for the applicability of a given product, service or technology in the humanitarian context – please consult the Humanitarian Assessment Report prepared by People In Need and Polish Humanitarian Action. The Report is enclosed; also available in the SharePoint.

Please describe below how the solutions addresses the needs.

The solution allows for:

- accelerating and improving the composting of organic waste
- recovering of the organic fraction from municipal solid waste from households
- production of valuable compost that could support local agriculture
- enhancing soil quality, helping to stabilize food production systems

IV. Logistic supply chains application potential - in which stage?

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The 'humanitarian supply chain' *is defined as: "The planning, procurement, storage, transport and delivery of different forms of supplies, works & services used for projects and to respond to emergencies. This includes the flow of supplies from origin to destination but also more complex work of forecasting, optimising resources, value for money to ensure the most efficient process, and decreasing the carbon footprint of related operations"*

Type of waste in humanitarian context:

COMMODITY TYPE	***PACKAGING***
Grains, cereals	*Virgin woven PP bags*
Cornmeal, fortified flour	*Hybrid paper bags and PP woven bags with PE*
Fortified vegetable oil	*Steel cans, plastic bottles, cardboard cartons*
Specialised nutritious food products	*Metallised flexible plastic sachets and pouches, plastic box liners, cardboard cartons*

TYPICAL NON-FOOD ITEMS
Tents, shelter kits, tarpaulin, synthetic sleeping mats, blankets, clothes, mosquito nets, timber, cement.
Nutrition-specialized products, such as Ready-to-Use Therapeutic Food (RUTF) and Ready-to-Use Supplementary Foods (RUSF); for example, Plumpy'Nut, vitamin A supplements, iron-folic acid supplements, and micronutrient supplements. These can be on tinplate or laminated packaging structures.
Medical supplies, wheelchairs, cold boxes.
Jerrycans/buckets (water containers), water purification tablets (Aquatabs, PUR), Water pumps, hygiene products (soap), menstrual hygiene products (single-use pads, reusable pads-ex. AFRIpads), water testing products, chemicals (such as chlorine), and equipment (for pump mechanics).
Stoves (fuel-efficient saving stoves), seeds, farming tools (hoes, axes, rakes, watering cans, buckets), storage (bags and sacks), fertilizers, pesticides, etc.
Paper, printed products, office equipment, electronic waste, etc.
Petroleum, oil, and lubricants. Electrical transformers with polychlorinated biphenyls (PCBs). Chemicals such as acid, chlorine, and pesticides. Asbestos-containing materials. Treated timber, etc.

Please indicate the link of the supply chain for which the solution can be applied? Describe how.

Identification of needs
.....
Conceptualization and planning
.....
Procurement – sourcing/ purchasing of products and services
.....
Goods collection in warehouses and repacking for transport to final destination
.....
Custom clearance
.....
Transport to the destination country (often multi-stage and using different modes of transport)
.....
Transport to the final destinations – last mile
.....
Storage at the final destination
.....
Operational logistic at final destination - distribution of goods and services
Reduction of organic waste, being the result of distributed goods and services.

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