GRASSIFICATION

D3.1.1 Market Study

Title	D3.1.1 Market study
Editor	
Contributors	Anouk Meeus (VITO)
Publication date	20.06.2019

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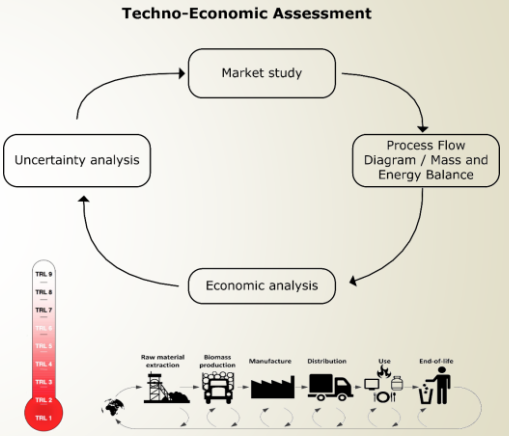
VITO tasks

- D3.1.1 - D3.1.4 – TEA for three value chains
  - **Market study**
  - Mass and energy balance
  - Economic analysis
  - Uncertainty analysis
- D3.2.1 - D3.2.3 – MooV
- D3.4.1 - D3.4.2 – Policy roadmap



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The Grassification project assesses the viability of innovative verge grass value chains by means of a techno-economic assessment (TEA). The TEA's are performed under responsibility of VITO. This report present the market study (D3.1.1), which is the first stage of the TEA. **The goal of the market study is to address the market trends, related prices, competitive processes and applications of the most promising Grassification value chains**. The final TEA-report will be a merger of this market study (D3.1.1), the energy & mass balance report (D3.1.2), the economic analysis (D3.1.3) and the sensitivity analysis (D3.1.4).

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SUMMARY

Product	Biogas
Price	0.09 - 0.22 €/m³
Potential (in Interreg 2 Seas region)	160 mio.Nm³/yr with 2 mio t roadside grass  200,000 households  1.12 % of 2 Seas area
Value of roadside grass	**7.2 – 17.6 €/t**
Grass input (dependent on digester type)	0 – 90 %
Grass conditions (dependent on digester type)	• Freshness • Timing of mowing • DM % • Max. % of inorganic material e.g. plastics, metals, etc. • Sand content • Length of fibres • Pretreatment steps

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Market study summary page on biogas.
The market study was performed on two key end-products: biogas and building materials (insulation materials & biocomposite panels).

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SUMMARY

Product	Insulation material	OR	Biocomposite panel
Price	10 – 15 €/m² 67 – 100 €/m³ (asm. 15 cm thickness)		45 – 65 €/m² 5,000 – 7,200 €/m³ (asm. 9 mm thickness)

Potential
 (in Interreg 2 Seas region)
	24 mio.m³/yr
	 with 2 mio t roadside grass
	  800,000 households
	  5 % of 2 Seas area
			3 mio.m³/yr
			 with 1 mio t roadside grass fibres
			  75,000 households
			  0.40 % of 2 Seas area

Value of roadside grass	**330 – 500 €/t** (asm. 80 % input)		**33,000 – 48,000 €/t fibres** (asm. 60 % input)
Grass input	0 – 90 %		0 – 70 %
Grass conditions	• Fresh grass		• High quality fibres: • Small/Short • High DM (dry) • Homogeneous • No sand, stones, litter, soil, ash, etc. • Low Sulphur content

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Market study summary page on insultation material and biocomposite panels. The market study was performed on two key end-products: biogas and building materials (insulation materials & biocomposite panels).

Table of content

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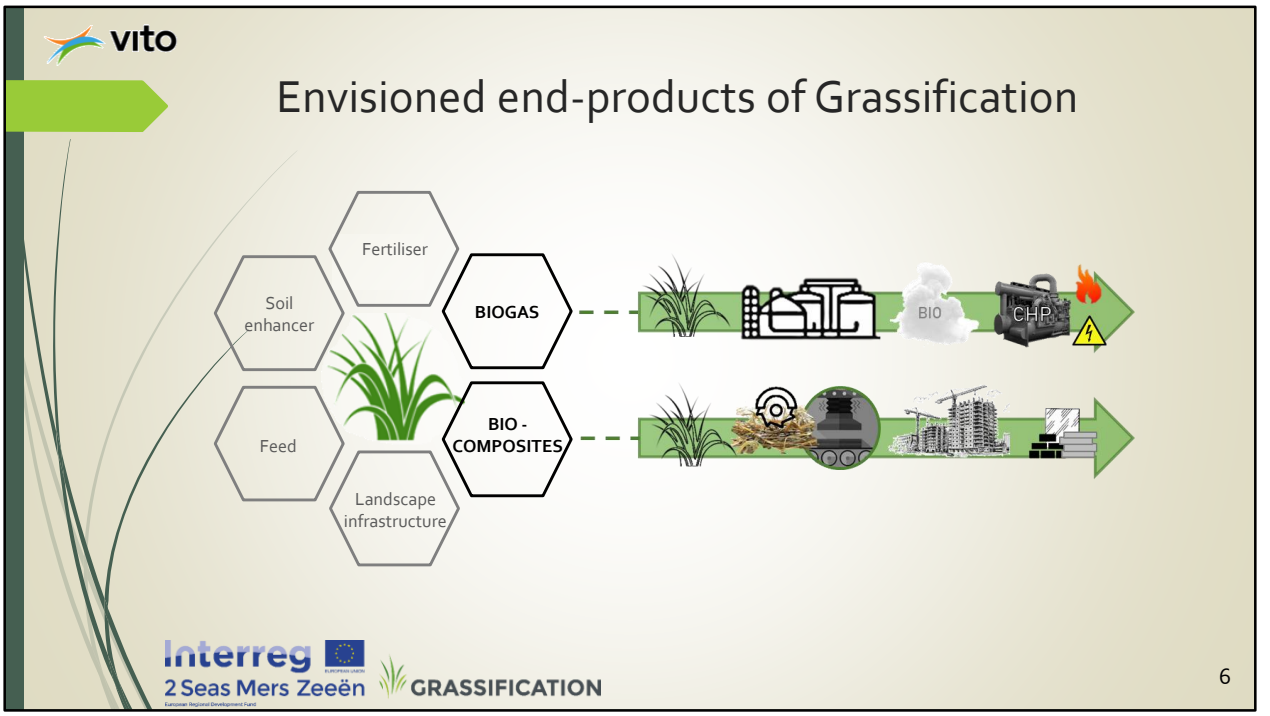
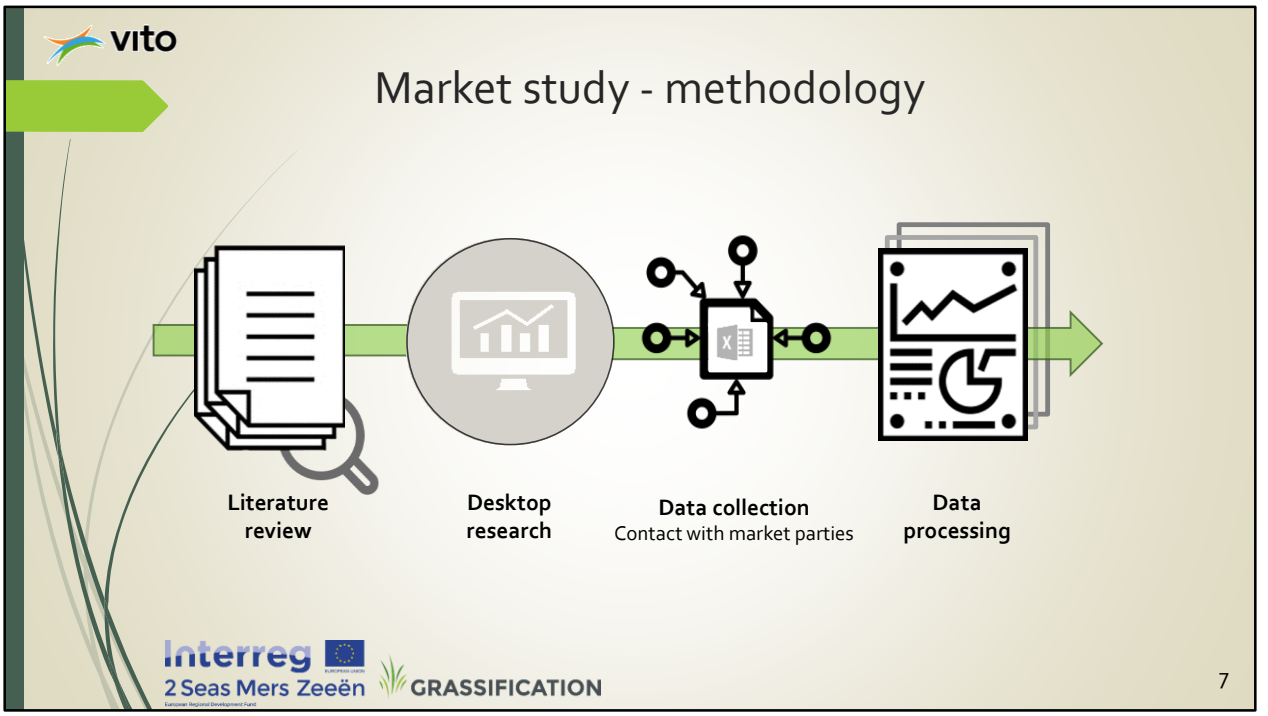
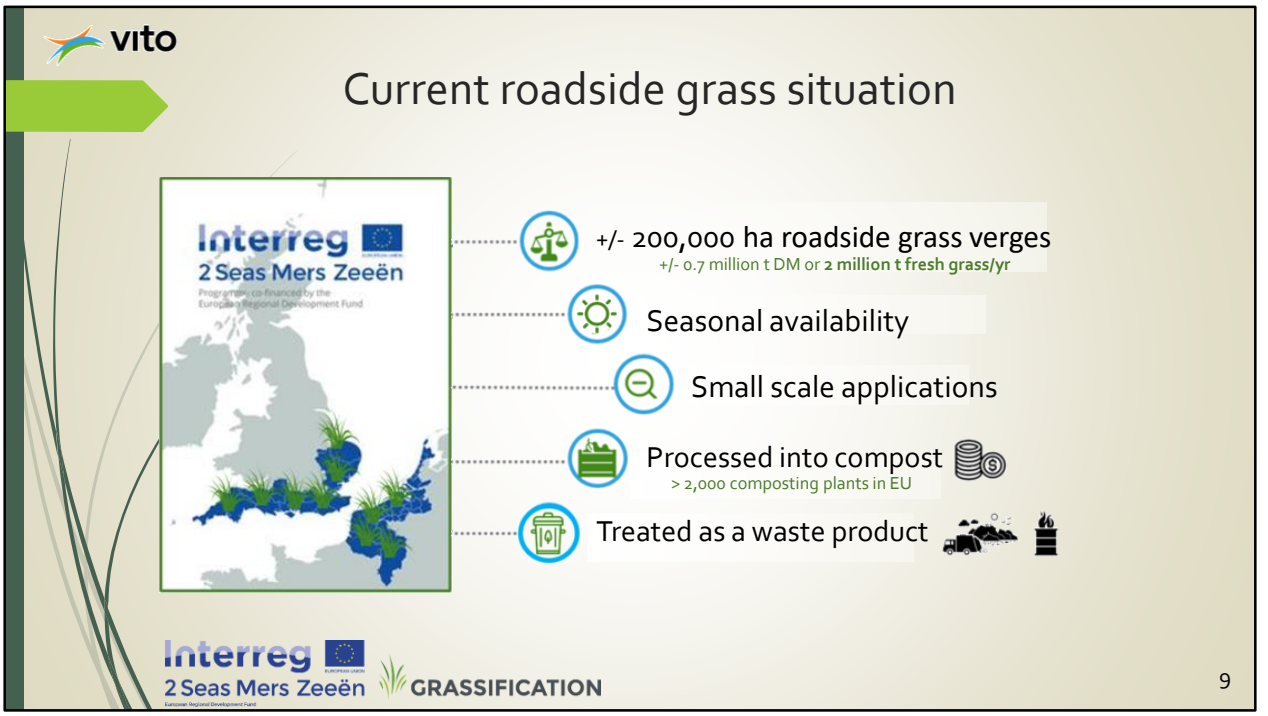


Within Grassification, the following end-products are envisioned: fertiliser, soil enhancer, feed, landscape infrastructure (e.g. plant poles and picnic tables), biogas and building materials. To determine which end-products to focus on in the market study, the project consortium was consulted and biogas and biocomposite building materials were chosen by majority.

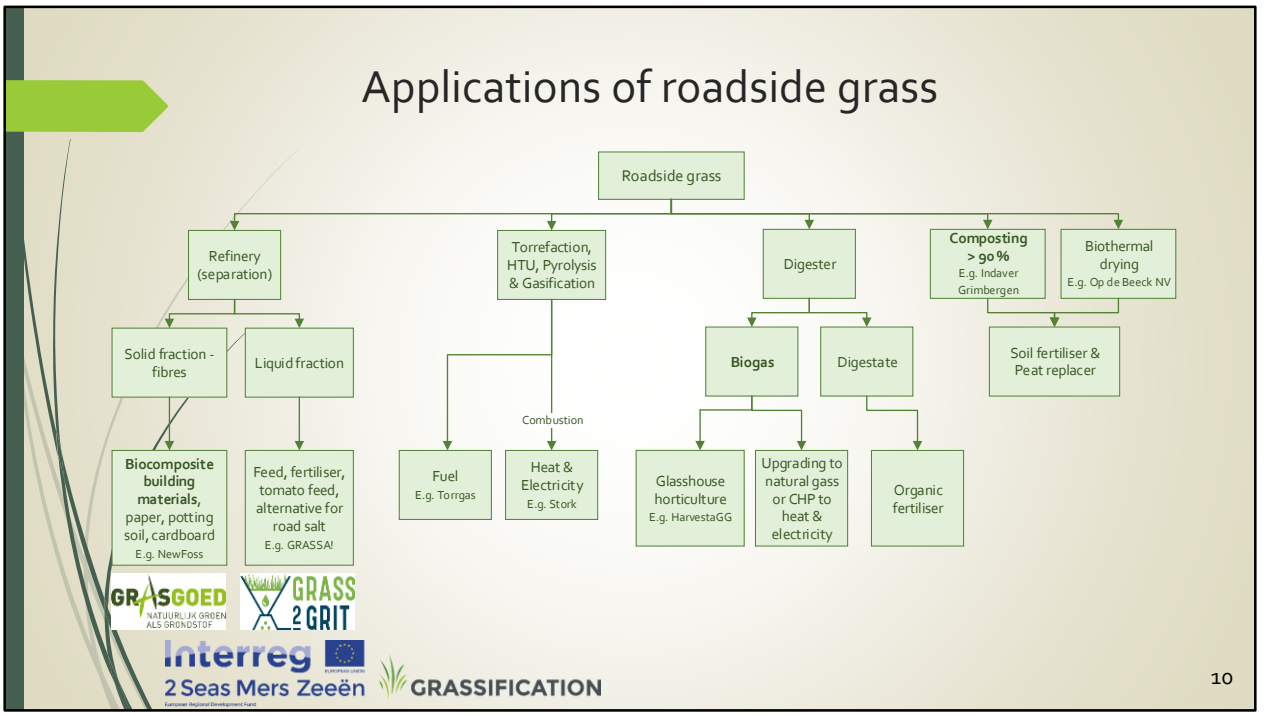


A literature review assessed the properties and possible applications of roadside grass in general; and biogas and building materials in specific. Next, a desktop research explored the market of these products. The resulting information was completed with data from relevant market parties collected via a survey (in the appendix to this presentation).

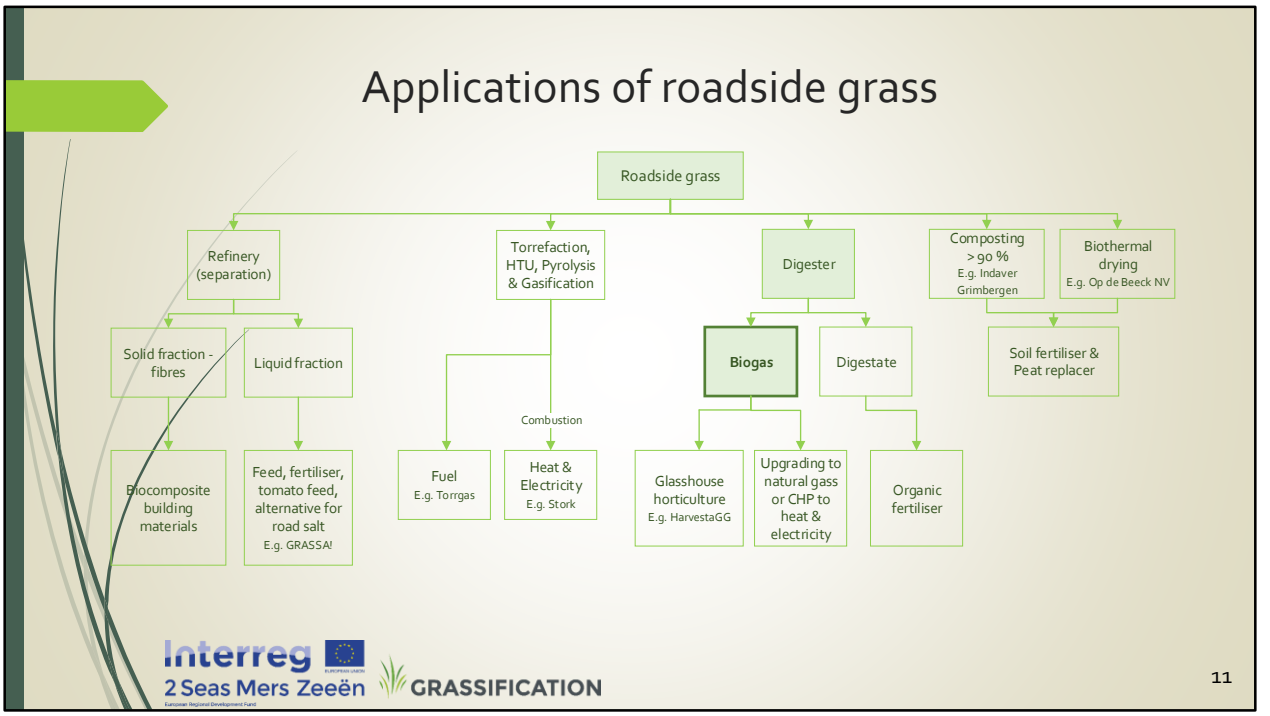
The assumptions behind the market potential calculations, based on literature and confirmed by market parties. The market potential of roadside grass is calculated for the 2 Seas area from a theoretical perspective, not taking into account the legal context (e.g. waste-status of verge grass). Legal and policy related issues are will be addressed in the Policy Roadmap (D3.4.1-2).



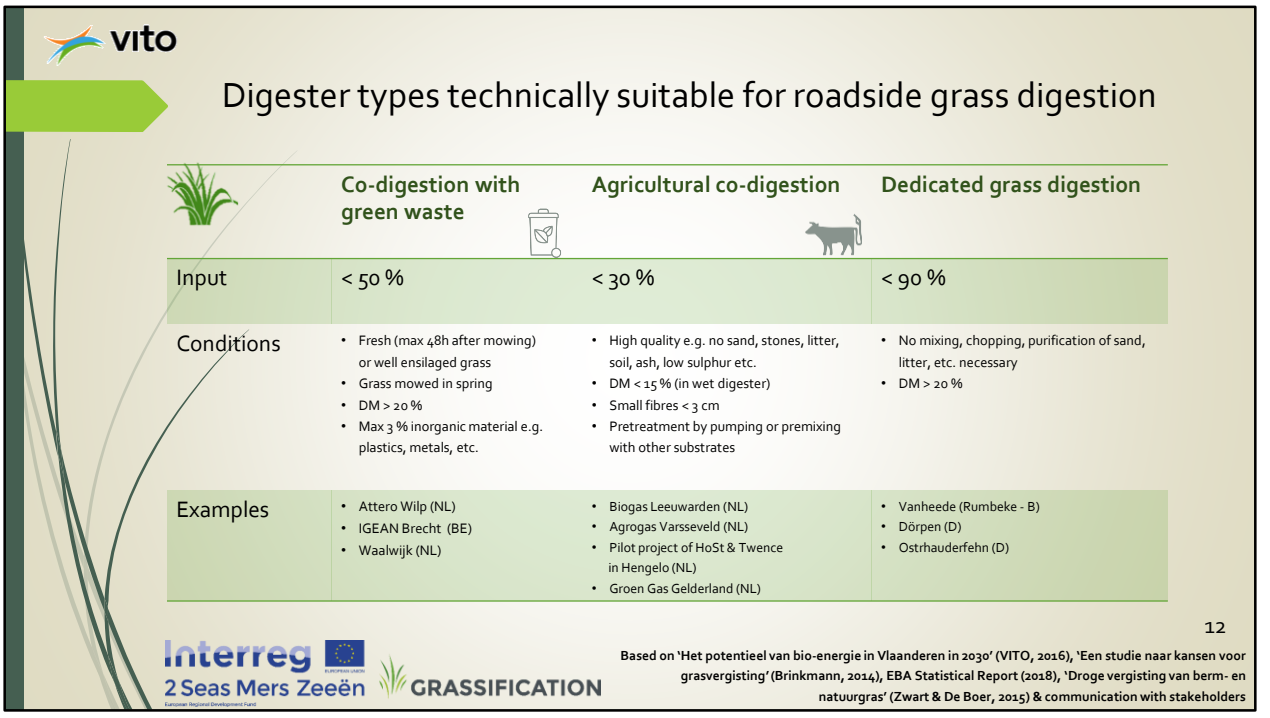
At this moment, roadside grass clippings are considered a problem throughout the 2 Seas area due to their high volume, seasonal availability and expensive processing methods. The industrial sector, however, is interested in the possibility of using roadside grass clippings as an alternative resource as opposed to fossil sources or dedicated agricultural produce.



At the moment, composting is the most frequent processing method of roadside grass resulting in soil improver and fertiliser as end-products. However the development of new applications is increasing. For example, roadside grass can be used for pyrolysis, anaerobic digestion and in biorefineries (e.g. fibers). For reference, some of the companies and projects working on these applications are mentioned.



First, the market potential of roadside grass in biogas is discussed.



There exist only a few digester types that are technically suitable to digest roadside grass. The first type is a codigester with green waste. At the moment, there exist approximately 30 plants in the 2 Seas area. The feedstock streams exist of vegetable, fruit and garden waste, organic municipal and industrial waste. Roadside grass can also be used as feedstock in these digesters, partly replacing green waste – specifically during winter. Roadside grass input can go up to 50 % without causing biological problems if the following conditions are met: it needs to be fresh, mowed in spring, dry and free from plastics, heavy metals and other contaminations. The current use of roadside grass as a feedstock by these digesters is very limited. For example, IGEAN Brecht used up to 25 % roadside grass input during 7 weeks for the project Bermgras.

The second type is an agricultural co-digester using mostly manure as feedstock, combined with agri-streams. There exist approximately 500 of such co-digesters in the 2 Seas area. Roadside grass can be used as feedstock in these digesters, partly replacing more expensive agri-streams. However agri-streams often have a higher biogas potential than roadside grass. Roadside grass input can go up to 30 % in a co-digester without causing technical problems if the conditions are met: the grass needs to be premixed, wet and free from plastics, heavy metals and other contaminations. Currently, only a few agricultural digesters are processing roadside

grass. For instance, Agrogas Varsseveld is using up to 10 % roadside grass.

The third digester type is a dedicated grass digester using mostly roadside grass as feedstock, combined with percolate liquid that is sprinkled over the biomass. There exist a few pilot installations in the 2 Seas area, mostly in Germany but the digestion process is still in the development phase. Roadside grass input can go up to 90 % without causing technical or biological problems if the grass is dry. There are advantages in comparison with the other digester types. For example, there is no need for mixing, chopping or purification. However since there are currently many unknown parameters and there is little experience, this digester type is not taken into account to calculate the biogas potential of roadside grass.

Contacted market parties already using roadside grass

for the production of biogas

Attero Wilp (NL)

Co-digestion with green waste

- Capacity: 250,000 t/yr
  - 80 % VFG waste
  - 60 % roadside grass in winter
- Production of 18 mio m³ biogas/yr
  - Joint generation of electrical & thermal energy in CHP
- Challenges:
  - Heavy metal content of grass
  - Make the valorisation of a waste stream financially interesting

Groen Gas Gelderland (NL)

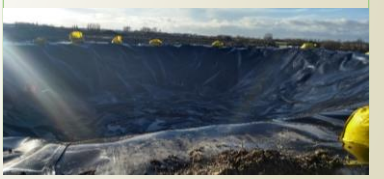
Agricultural co-digestion

- Capacity: 72,000 t/yr
  - 50 % animal manure
  - 49 % agri-food streams
  - 1 % or 7,000 t roadside grass
- Production of 10 mio m³ biogas/yr
  - 100 % green gas
- Challenges:
  - Possibilities for upscaling
  - Create a high methane content
  - Digestate goes to own waste incineration & looking into the application in chemicals

Vanheede Rumbeke (B)

Dedicated grass digestion

- Pilot installation: starting up-phase
- Capacity: 500 t/landfill cel
  - 50 % digestate incl. inoculum
  - 50 % or 250 t roadside grass
- Production of 27,000 m³ biogas/cel *
  - Joint generation of electrical & thermal energy in CHP
- Challenges:
  - Acidification
  - DSP of digestate



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These three companies are examples of market parties that were contacted regarding the use of roadside grass in their digesters. - Attero Wilp in the Netherlands is a co-digester with green waste with a capacity of 250,000 tonnes per year. They use 60 % of roadside grass input during winter to replace green waste.

- Groen Gas Gelderland in the Netherlands is an agricultural co-digester with a capacity of 72,000 tonnes per year including 1 % or 7,000 tonnes roadside grass.

- Project partner Vanheede is building a pilot biogas installation on its landfill using approximately 250 tonnes of roadside grass per batch.

* Biogas production based on figures received from Vanheede.

Biogas potential of roadside grass

in co-digesters with green waste in 2 Seas area

Feedstock	Status quo (2019) (mio.t/yr)	Potential (mio.t/yr)	Biogas potential (Nm^3/t)	Biogas Production (mio.Nm^3/yr)	Primary production (GWh_p/yr)	Electricity production (GWh_e/yr)	Thermal Production (GWh_{th}/yr)
Roadside grass		**0.4** **= 25 %**	**80**	**32** Incl. 55 % CH_4	**176**	**79**	**97**
VFG waste	1.2	1.2 = 75 %	100	120 Incl. 60 % CH_4			
Total	1.2 = 30 biogas installations	1.6 = 40 biogas installations		152			

22,000

18,000

0.13 %

0.10 %

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Based on 'Optimising UK urban road verge contributions to biodiversity and ecosystem services with cost-effective management' (O'Sullivan et al., 2017), Biogas-E vzw (2017), Graskracht (2012) & 'Het potentieel van bio-energie in Vlaanderen in 2030' (VITO, 2016)

Currently there is approximately 1.2 million tonnes of VFG waste digested in 30 co-digesters using green waste in the 2 Seas area. Very few of these digesters already use roadside grass so it is not included as feedstock in the status quo. In literature was found that 25 % roadside grass input was the most realistic amount to use as feedstock in these type of digesters. Next, a range between 60-100 Nm^3/ton biogas production potential was found for roadside grass - an average of 80 Nm^3/ton was used.

Biogas production calculations were made based on these assumptions resulting in a biogas production potential of 32 million Nm^3 biogas per year. This amount can provide circa 22,000 households with electricity and 18,000 households with heat. In total this includes about 0.25% of the electricity and heat consumption in the 2 Seas area.

Biogas potential of roadside grass

in agricultural co-digesters in 2 Seas area

Feedstock	Status quo (2019) (mio.t/yr)	Potential (mio.t/yr)	Biogas potential (Nm^3/t)	Biogas Production (mio.Nm^3/yr)	Primary production (GWh_p/yr)	Electricity production (GWh_e/yr)	Thermal Production (GWh_{th}/yr)
Roadside grass		**2** **= 5 %**	**80**	**160** Incl. 55 % CH_4	**880**	**396**	**484**
Animal manure	20 = 50 %	20 = 50 %	75	1,500 Incl. 50 % CH_4			
Agri-food steams e.g. maize	20 = 50 %	18 = 45 %	185	3,330 Incl. 65 % CH_4			
Total	40 = 500 biogas installations	40 = 500 biogas installations		4,862			

110,000

88,000

0.62 %

0.50 %

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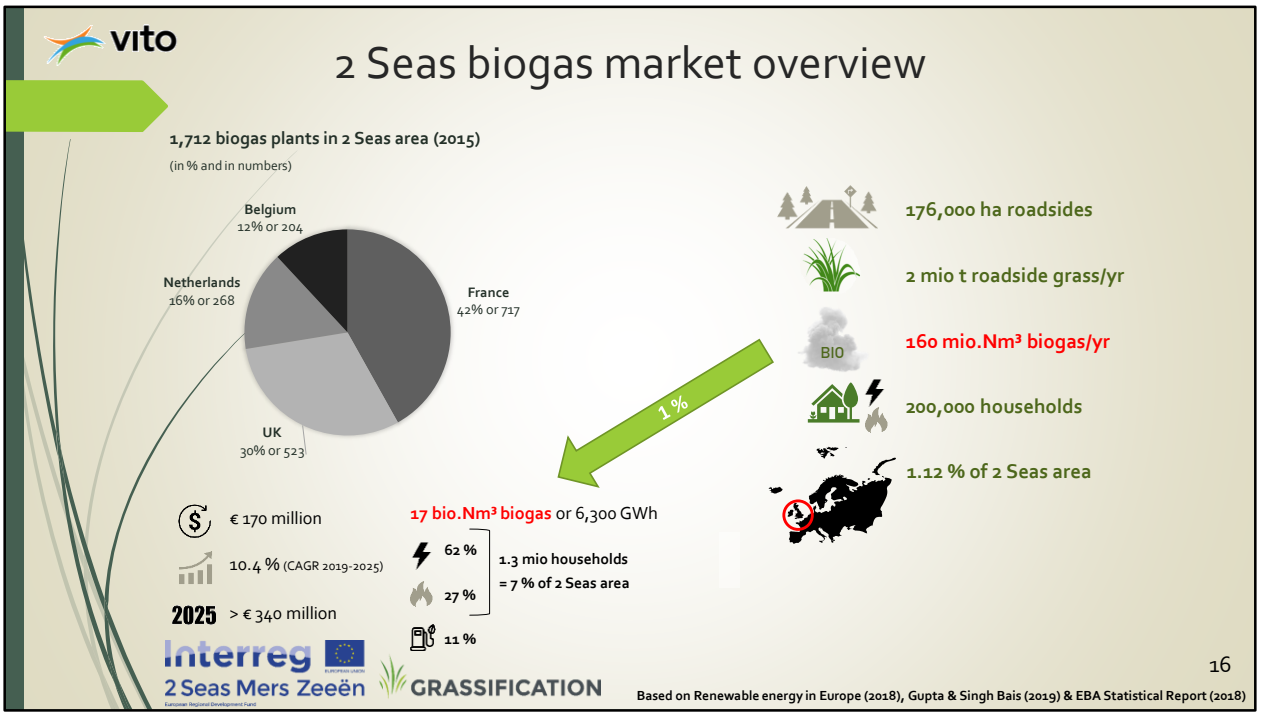
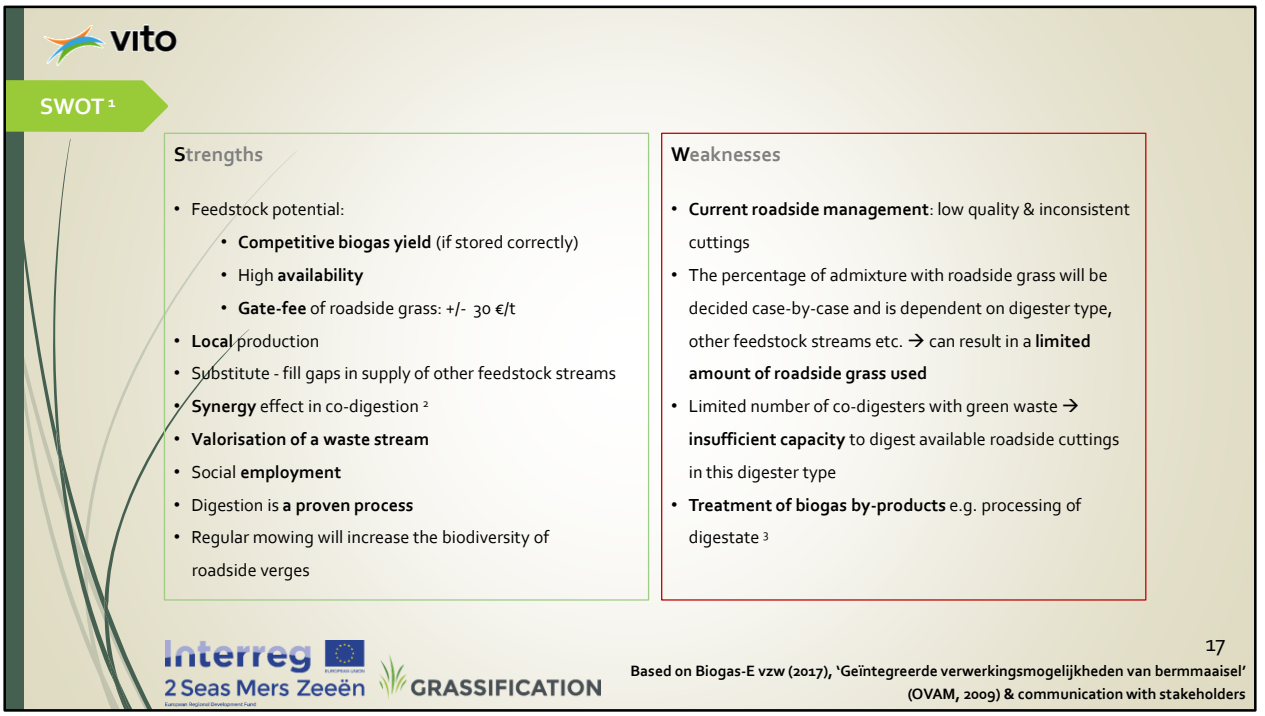
Based on 'Optimising UK urban road verge contributions to biodiversity and ecosystem services with cost-effective management' (O'Sullivan et al., 2017), Biogas-E vzw (2017), Graskracht (2012) & 'Het potentieel van bio-energie in Vlaanderen in 2030' (VITO, 2016)

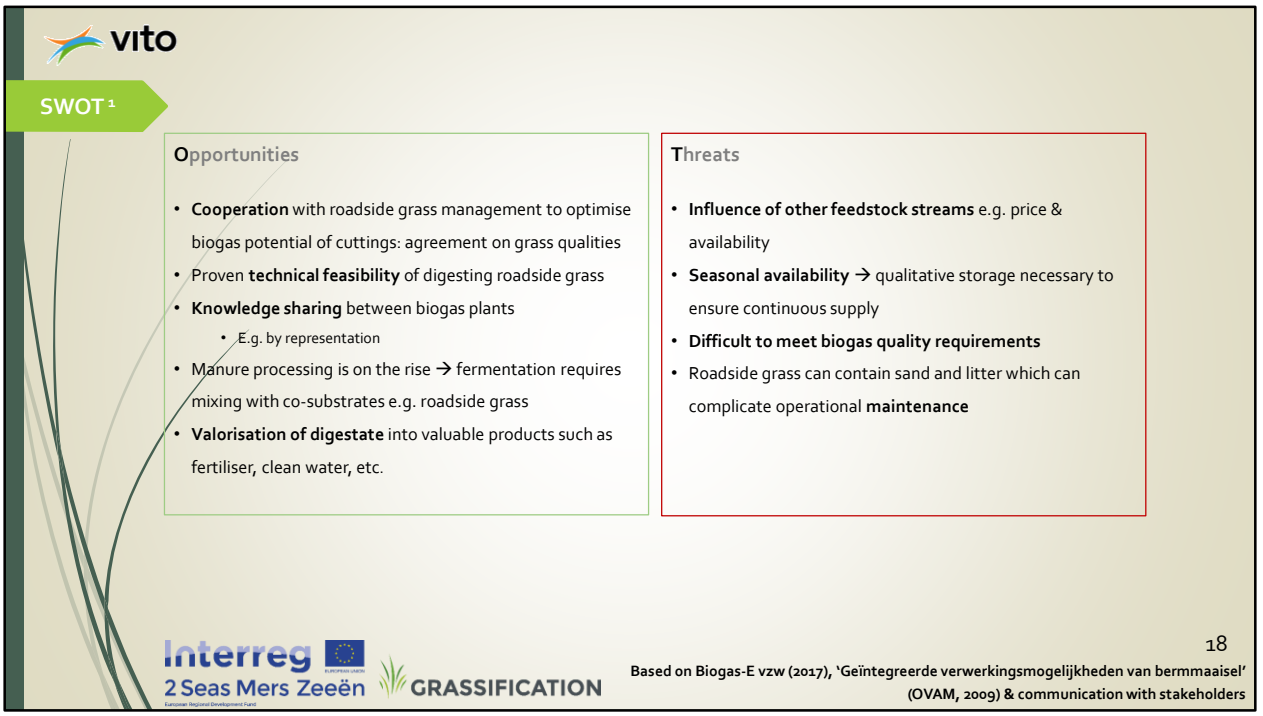
At the moment, there is approximately 40 million tonnes digested in 500 agricultural co-digesters in the 2 Seas area. Only a few of these digesters already use roadside grass so it is not included as feedstock in the current state of the art. Assuming a roadside grass potential of 2 million tonnes for the area, partly replacing agri-streams, the biogas production results in 160 million Nm^3 of biogas per year. This amount can provide 110,000 households with electricity and 88,000 households with heat. In total this includes almost 1.2% of the electricity and heat consumption in the 2 Seas area.



The 2 Seas biogas market overview shows 1,712 biogas plants in total in the area; France has 717 biogas installations, followed by the UK, Netherlands and Belgium (based on total surface of these countries). These digesters produced a total of 17 billion Nm^3 of biogas which was primarily used for electricity and heat production and only a marginal amount was used as transport fuel. The market value for this area is estimated to be EUR170 mio and expected to grow to EUR 340 mio by 2025 at a growth rate of 10 %. Under the assumptions made, the 2 Seas area consists of 176,000 hectares of roadsides producing yearly roughly 2 mio tonnes of grass – which potentially can produce 160 mio Nm^3 of biogas Compared to the current market, digesting all produced roadside grass would only make out 1 % of the market (under the assumptions made),



Note 1: Policy related issues are addressed in D3.4.1 - Policy Landscape Analysis
Note 2: Roadside grass keeps the C/N ratio in balance (at 15 – 30 level). This limits the risk of inhibition. Moreover, the grass holds potential to increase the biogas yield per kg of product, which is rather low for manure given its relatively low organic matter content.
Note 3: Digestate can be further processed by hygienising, separation, drying, evaporating, ultrafiltration, reverse osmosis, etc. Furthermore, there are several processing techniques in development. At the moment, there exist several applications of digestate: fertiliser (replacement), compost, waste, etc.



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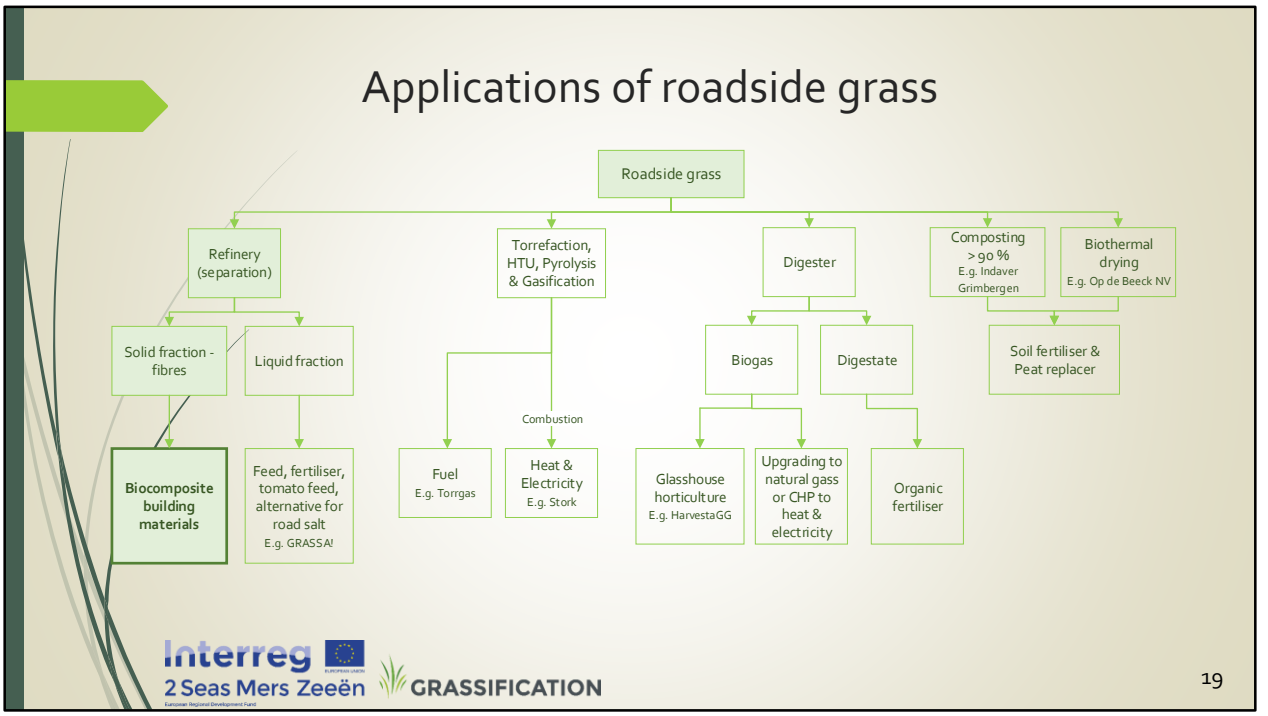
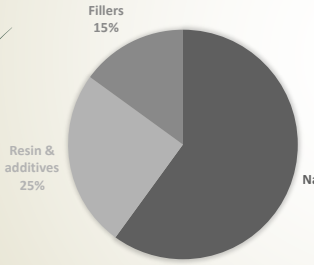


Next, the market potential of roadside grass in biocomposite building materials is discussed.

Biocomposites are materials formed by resin and a reinforcement of natural fibers. The resin is made from polymers and important to protect the fibers from environmental degradation and mechanical damage and to hold the fibers together. Furthermore, the natural fibers are the principal components of biocomposites, which are derived from biological origins e.g. from crops (cotton, flax or hemp), recycled wood, waste paper, grass or regenerated cellulose fiber. Biocomposite materials for construction entail decking, fencing, poles, panels, insulation, boards, etc.

Production of biocomposites

- Pretreatment: pressing of fibres
  - Pressed fibres → biocomposite building materials e.g. decking, panel boards, insulation materials, etc.
  - Nutrient rich juice → digester, feed, fertiliser, bioplastics, road salt, microalgal cultivation, tomato feed, etc.
- Input:



60 %	Wood
13 %	Flax
9 %	Kenaf
8 %	Hemp
5 %	Cotton
4 %	Other
1 %	Grass

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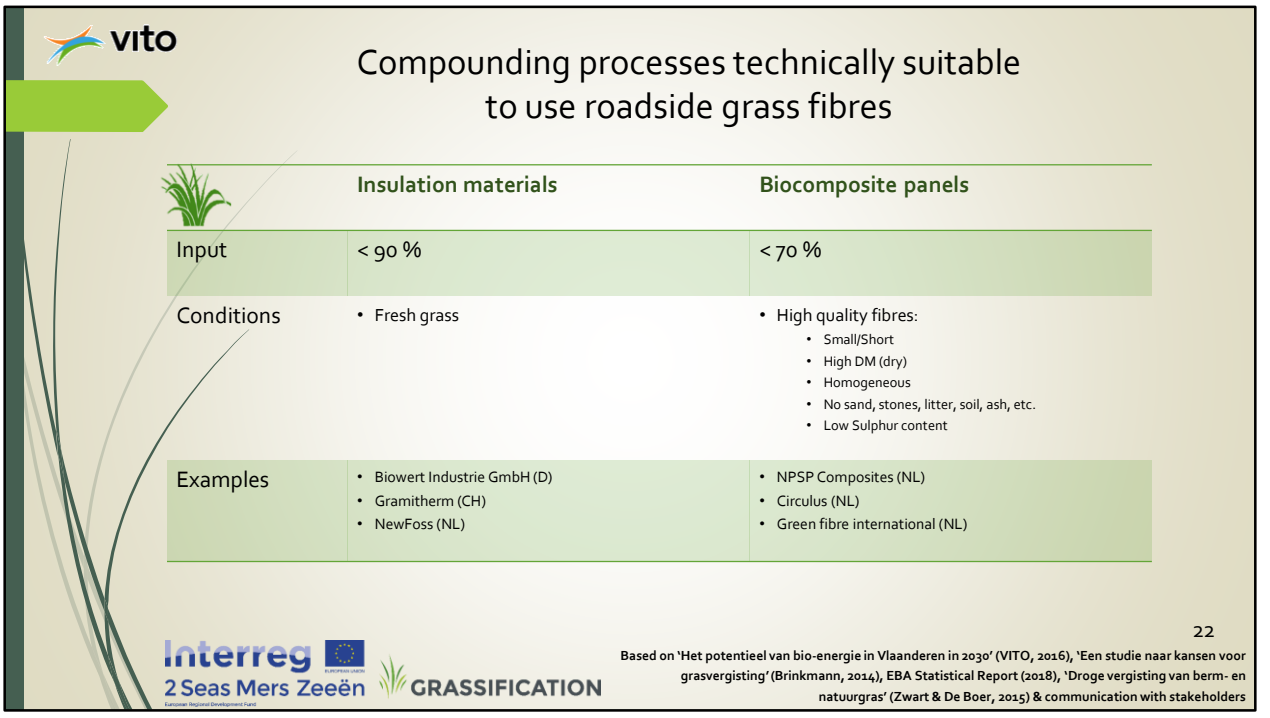
Based on 'Natural Fibre Composites: Saving weight and cost with renewable materials' (Brouwer), 'Natural fibres, Biopolymers, and Biocomposites' (Amar et al., 2005), 'Biocomposites for the construction materials and structures' (Yatim et al., 2011) & communication with stakeholders

Biocomposites are produced by compounding or extrusion of natural fibers with resin, fillers and additives. The composition and quantities of these inputs are dependent on the quality specifications of the envisioned end-product and determine the compounding process. A typical composition of a biocomposite is 60 % fibers, 25 % resin and additives and 15 % fillers. Examples of natural fibers are grass, wood, cellulose, hemp, flax, jute, kenaf, bamboo, cork, etc. The average use of these fibers in biocomposites are shown. The resin can be a petrochemical plastic such as PE or a biopolymer such as PLA for instance.



The compounding processes used to produce biocomposite building materials are suited to use roadside grass fibers if they account for less than 70 % of the input in biocomposite panels and less than 90% in insulation material. For the roadside grass fibers in biocomposite panels it is important that they are dry, not contaminated with soil, litter, sand, short and fresh in case of insulation.

Contacted market parties already using roadside grass

for the production of biocomposite building materials

NewFoss (NL)

Production of insulation boards, potting soil, paper, etc.:

- Extraction of raw grass cellulose fibres → insulation
  - Capacity: 330,000 m³ NFF-ISO/yr
  - 75 – 90 % or 130,000 t roadside grass fibres
- Liquid fraction → fertiliser, bioplastics, etc.
- Applicable for roofs, attics, ceilings, walls & floors
- Fully recyclable materials
- Protection against heat, cold, fire & fungi

Circulus (NL)

Specialised in processing roadside grass:

- Production of natural fibres to use in biobased benches, picnic tables, poles, etc.
- Valorisation of waste streams:
  - < 70 % natural fibres
  - > 30 % recycled plastics
- Focus on full value chain: from biomass to end-product(s)
- E.g. reflector pole made of 50 % grass fibres from roadsides & 50 % recycled plastics

NPSP Composites (NL)

Manufacturer of sustainable fibre reinforced plastics for construction, design, transport & industry:

- Most of their construction applications are based on glass fibre composites e.g. benches or decking
- Development of biocomposite material Nabasco® 8010 made from biobased resin (from waste of biodiesel production), calcium carbonate & fibres from roadside grass, recycled toilet paper, textile, flax and waste cane
  - Protection against heat & fire
  - E.g. a biobased façade

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These three companies are examples of market parties VITO contacted in view of the use of roadside grass in the production of building materials. The first one is NewFoss in the Netherlands, which is a producer of insulation material with a capacity of 330,000 tons per year using 80 % roadside grass fibers on average or circa 130,000 tonnes. Next, Circulus is specialized in processing roadside grass into biocomposite benches, picnic tables. NPSP Composites is a manufacturer of fiber reinforced plastics for the construction and other sectors. They produced a biocomposite facade panel that contains a small fraction of roadside grass fibers.

Potential of roadside grass

in biocomposite building materials in 2 Seas area

Feedstock	Potential (mio.t/yr)	Insulation production (mio.m³/yr)
Roadside grass	**2** = 80 %	**24**
Additives	0.50 = 20 %	
Fillers		
Total	2.50 = 6 production plants	

800,000

5 %

OR

Feedstock	Potential (mio.t/yr)	Biocomposite panel production (mio.m³/yr)
Roadside grass fibres	**1** = 60 %	**3**
Resin & additives	0.40 = 25 %	
Fillers	0.30 = 15 %	
Total	1.7	

75,000

0.40 %

24

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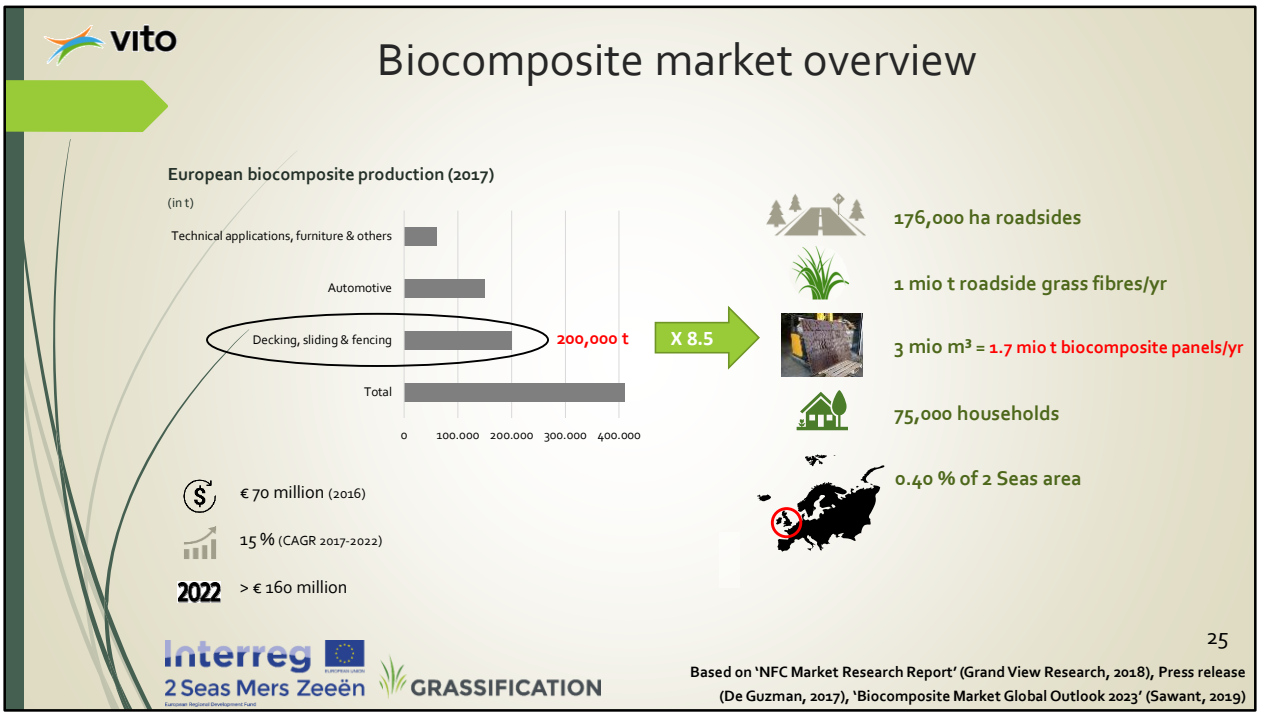
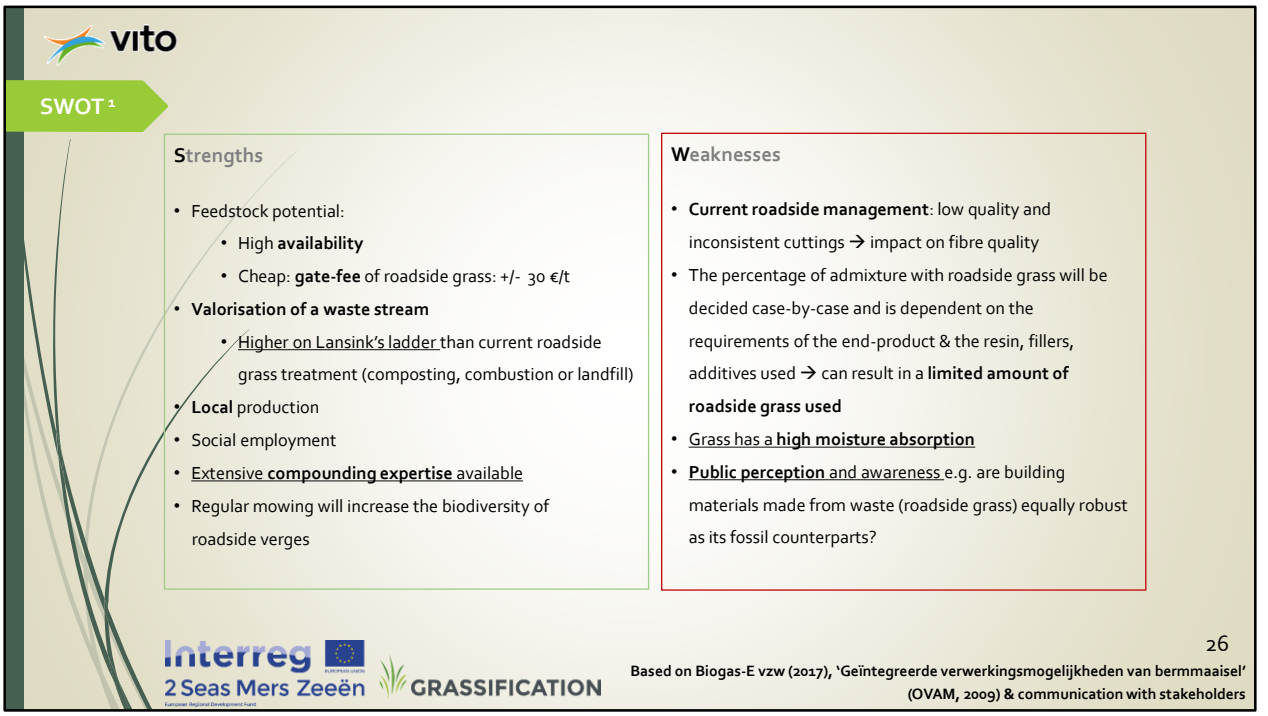
Based on 'Optimising UK urban road verge contributions to biodiversity and ecosystem services with cost-effective management' (O'Sullivan et al., 2017), Biogas-E vzw (2017), Graskracht (2012) & 'Het potentieel van bio-energie in Vlaanderen in 2030' (VITO, 2016)

Assuming that 80% of the insulation input is roadside grass and there is 2 million ton available in the 2 Seas area with a insulation potential of 12 m^3 per ton then this results in a theoretical yearly production potential of 24 million m^3 insulation material. This amount can isolate 800,000 households or 5 % of the two seas area. Alternatively 1 million ton of roadside grass fibers can be used in biocomposite panel production instead of insulation. In this case, it is possible to produce biocomposite facade panels for 75,000 houses or 0.40 % of the 2 Seas area.



Looking at the biocomposite market the overview shows that the European production volume of biocomposite decking, sliding and fencing in 2017 was 200,000 tonnes. The European biocomposite market value was almost 70 million euros in 2016 and is expected to grow to 160 million euros by 2022 at a growth rate of 15 %. Under the assumptions made, the roadside grass produced in the 2 Seas area can be used to provide 75,000 households with façade panels or 0,40 % of the area. Comparing this to the existing market, this means that the production volume would multiply by 8.5 (under the assumptions made) and could have a significant impact on the current market. However, the likeliness of all the available roadside grass fibers in the area going to biocomposite panels is low and the production of decking, sliding and fencing is only a small part of the existing biocomposite market.



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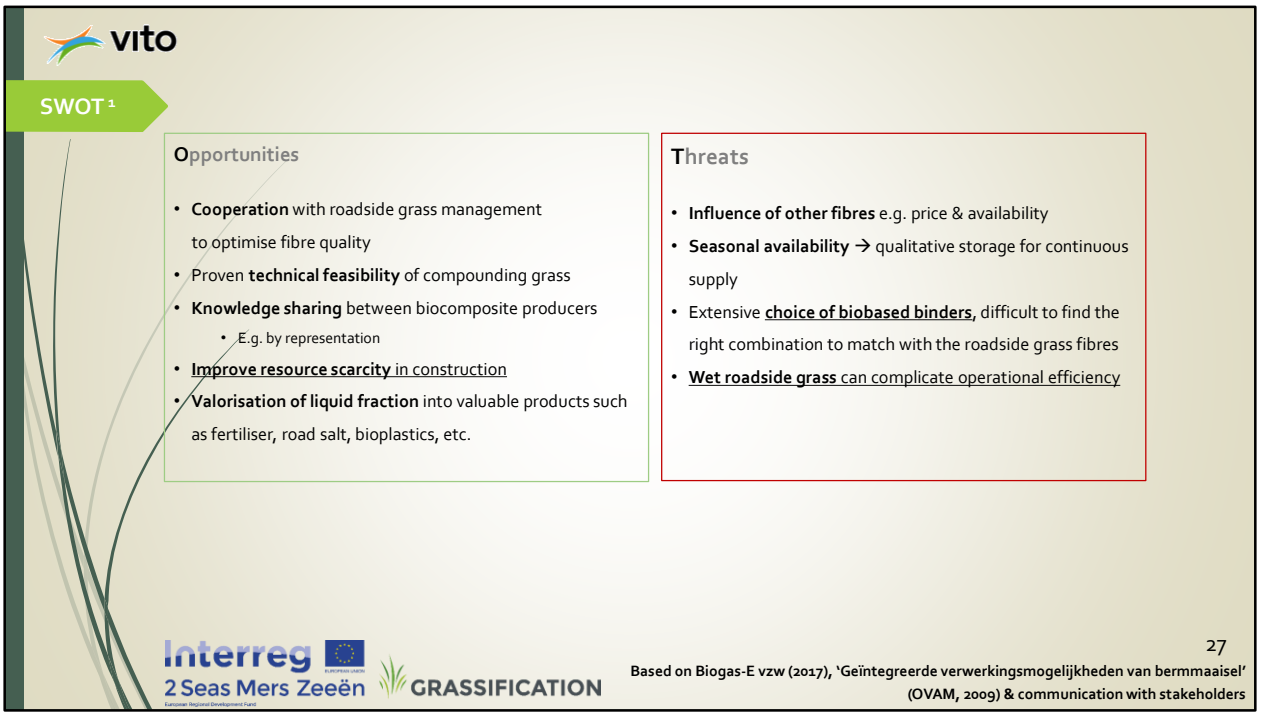

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Partners

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Appendix

Questions asked to stakeholders:

- Are you working on applications of roadside grass (e.g. building materials, biogas, …)? Are you familiar with any other applications?
- Who is your typical customer? Who is the targeted customer?
- What is the reason for interest in grass applications? What are important characteristics/main selling points?
- Do your products have advantages compared to the current products on the market? Please define.
- Could you estimate the current market demand and production volume of your products? Please use references if possible.
- Do you expect the market of your products to grow? What is the current value of the market and the expected CAGR?
- What features and attributes are needed for the products to be successful?
- How much grass is used in the end-product? E.g. kg grass/t product
- Would the customer pay a higher price for your product compared to conventional products? Why? What is the price of your end-product?
- What are the main bottlenecks/challenges you are facing in developing your technology?
- Do you know if other organisations are investigating the same technology or a similar technology? Do you know other main actors in the field?

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In total, we had contact with 20 stakeholders, including 7 project partners, 7 biogas installations, 4 biocomposite producers, one Combine project partner and one biogas network representative.