MUSIC
Market Uptake Support for Intermediate Bioenergy Carriers

Residual biomass mobilisation strategies based on intermediate bioenergy carriers

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18th International Conference on Renewable Resources and Biorefineries, Bruges/Belgium , 1 - 3 June 2022

ΚΑΠΕ CRES CERTH

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- MUSIC project
- Intermediate bioenergy carriers
- The Greek Case-study
- Biomass supply strategies
- Conclusions

RATIONALE & OVERALL OBJECTIVE

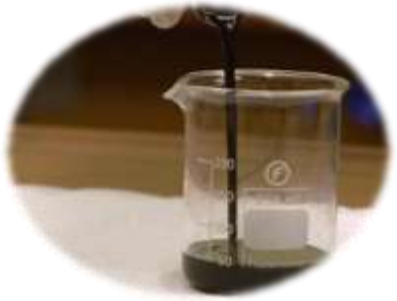
Why Intermediate Bioenergy Carriers – IBCs ?

- Biomass is bulky and difficult to handle.
- Converting it into intermediary products like **Pyrolysis Oil**, **Torrefied Biomass** & **Microbial Oil** increases the energy density and makes it easier to transport, store and use.

General objective

- To facilitate the further introduction of intermediate bioenergy carriers by developing feedstock mobilisation strategies, improved logistics and IBC trade centres.

INTERMEDIATE BIOENERGY CARRIERS

Pyrolysis oil	Torrefied biomass	Microbial oil
		
Obtained by fast heating of biomass in the absence of oxygen, resulting in a liquid IBC.	Obtained by slow heating of biomass in the absence of oxygen, resulting in a solid IBC.	Obtained by fermentation of lignocellulosic-derived sugars from biomass, resulting in a liquid IBC.

GREEK CASE STUDY: USE OF TORREFIED BIOMASS IN DISTRICT HEATING PLANT

- Operates an extensive district heating network – **2,000** public and residential buildings – **3,000** to **5,000** consumers.
- From **2005** until **2020** – heat capacity from Amyntaio CHP plant at **7€/MWh.**
- Implemented a **30 MW_{th}** biomass/lignite co-firing district heating plant.
- Current fuel-mix (**50%-50%** energy ratio).
  - Wood-chips **(20 €/MWh)**
  - Lignite **(13€/MWh)**
- Produced **heat selling price** rose from **41,3 €/MWh** (2019) to **56,8 €/MWh** (2021).

Biomass feedstocks with diverse characteristics → Difficulties in handling/firing

+

Lack of cooperation with local producers → Unexploited quantities

+

Difficulties in biomass contractualization → Unstable prices

+

Seasonal variability → Quantities/Properties → Insecurity of supply

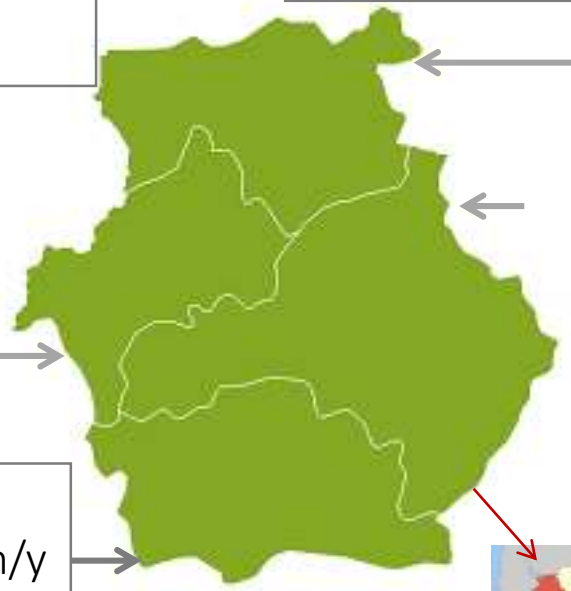
=

Inability to utilize the full potential of local biomass capacities → Need for organizing biomass mobilization by involving local stakeholders

Theoretic biomass potential in West Macedonia

Kastoria region:
Total biomass:~ 47,000 t dm/y
- 41,000 t dm/y mainly straw
- 4,000 t dm/y pruning
- 1,800 t dm/y firewood

Florina region:
Total biomass:~ 120,000 t dm/y
- 104,000 t dm/y cereals (of which 55,600 t dm/y is corn residues)
- 11,000 t dm/y pruning (vineyards, fruit trees)



Kozani region:
Total biomass:~ 225,000 t dm/y
- 203,000 t dm/y cereals (of which 50,000 t dm/y is corn residues)
- 8,000 t dm/y pruning (vineyards, fruit trees)

Grevena region:
Total biomass:~ 91,000 t dm/y mainly straw

Biomass availability

- Availability of biomass near the district heating plant is significant, including mainly corn stalks and cobs and tree pruning, still not exploited due to challenging logistics.

Biomass availability year around												
Months	1	2	3	4	5	6	7	8	9	10	11	12
Straw						■	■	■				
Corn and sunflower residues									■	■	■	
Pruning	■	■	■									■
Forest residues						■	■	■	■			
Residues from forest industries	■	■	■	■	■	■	■	■	■	■	■	■

BIOMASS MOBILIZATION

Truck

10-50 km

Residues transferred directly to the district heating plant

Straw/ corn residues/pruning

Truck

10-50 km

Residues transferred in the torrefaction unit

or

Torrefaction unit

Truck

~10 km

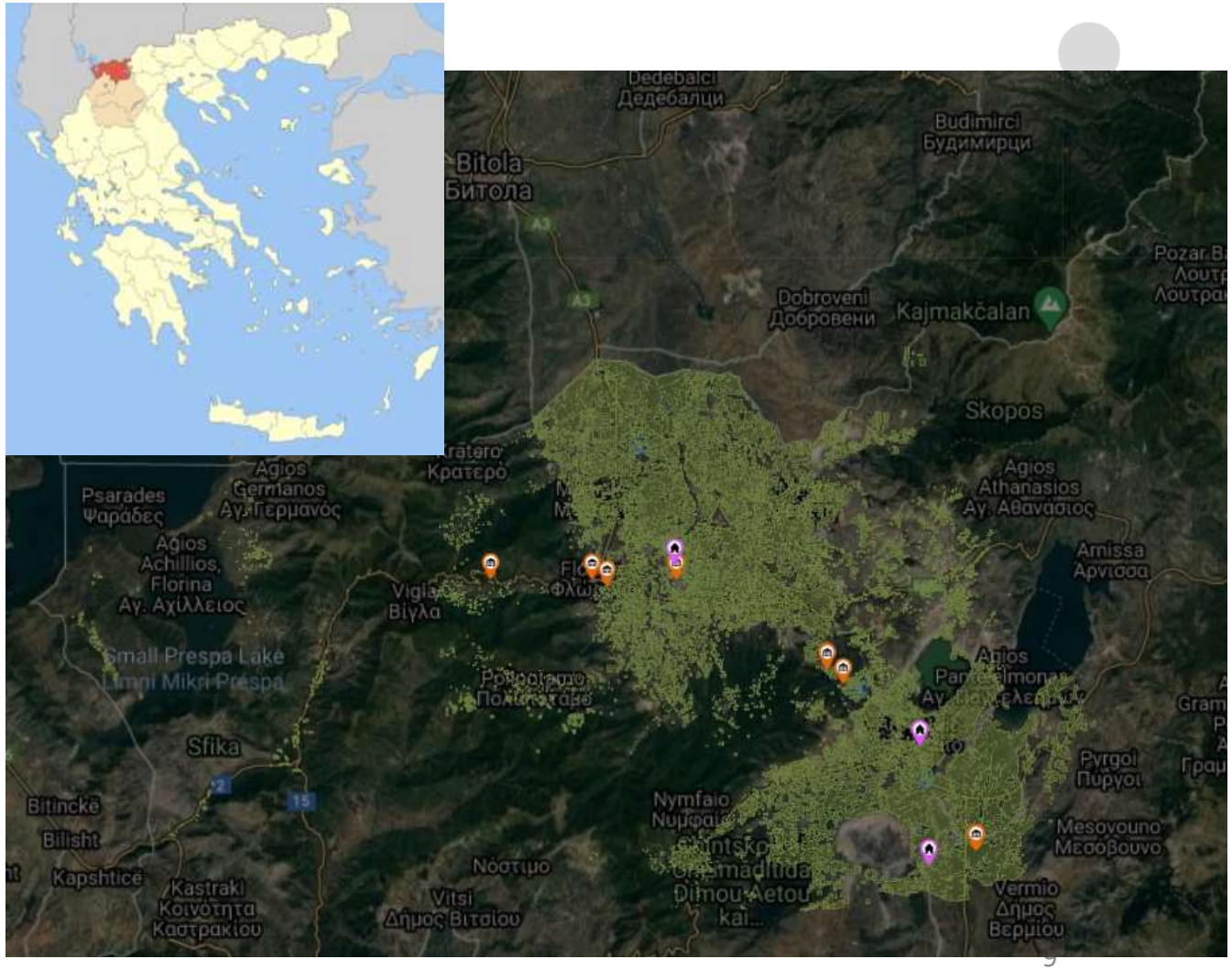
DETEPA 30 MWth Amyntaion DH plant

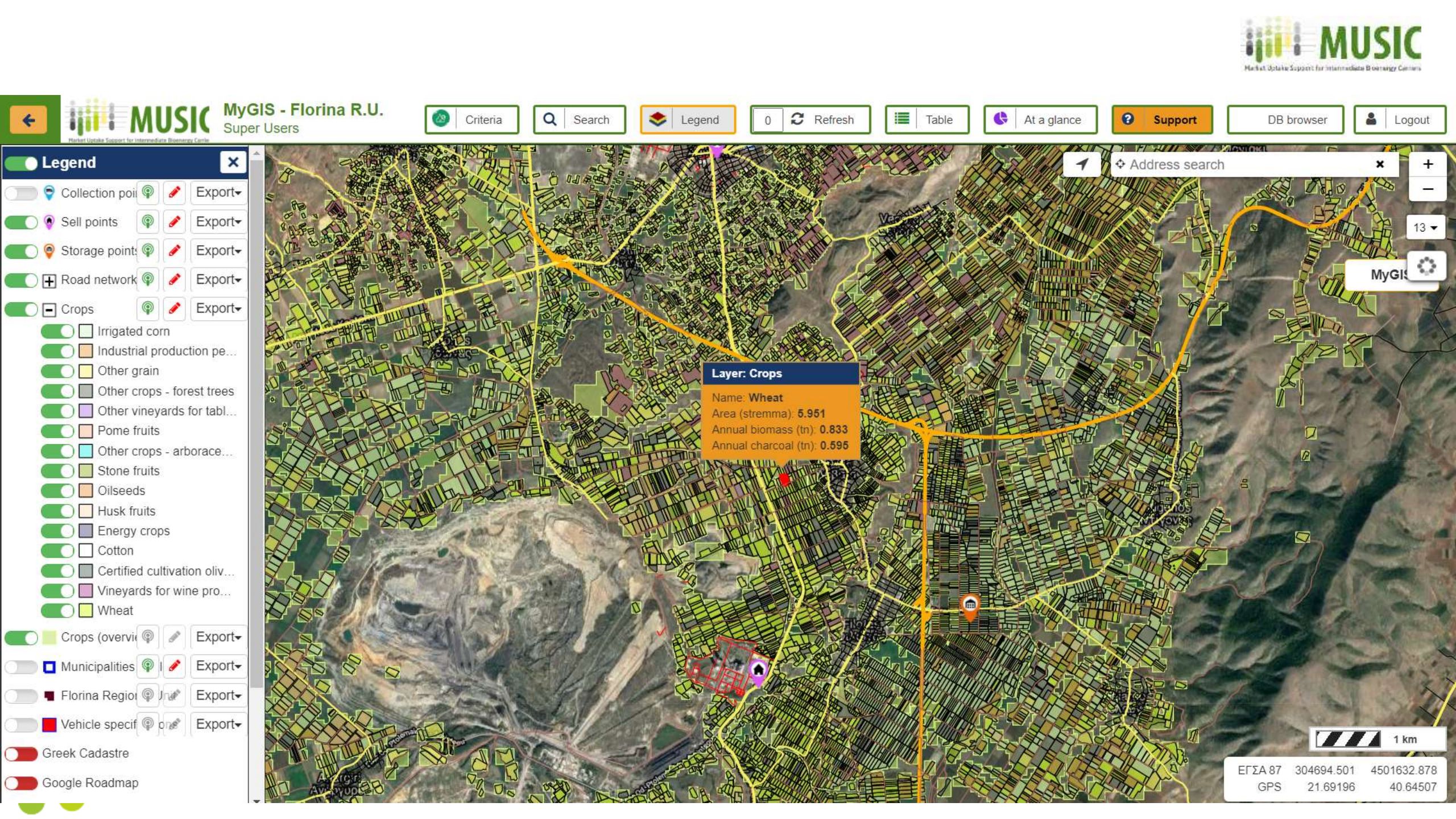
Music-mygis model

Objective: A GIS application to help the user select the fields where the biomass will be collected, places to be stored/torrefied and sold and calculate the related logistics costs.

MODEL PARAMETERS

- **Selling point**: the final destination of the biomass (client).
- **Transportation vehicle**, which will transport the biomass from the storage point to the selling point. Each vehicle type takes into consideration:
  - Capacity (volume)
  - Maximum payload (weight)
  - Biomass packaging type (e.g.. Big bags, rectangular bales, etc.)
  - Transportation cost (Fuel/oil consumption and costs, service costs etc.)
  - Time and cost to load/unload
- **Storage point**: is the collection point of all biomass before it is transported to the client.
- **Collection vehicle**, which will transport the biomass from the collection points to the storage point. It has similar functionality to the transportation vehicle.
- **Crops**: Crop residues (maize, vineyards, pome fruits, stone fruits and other tree species).



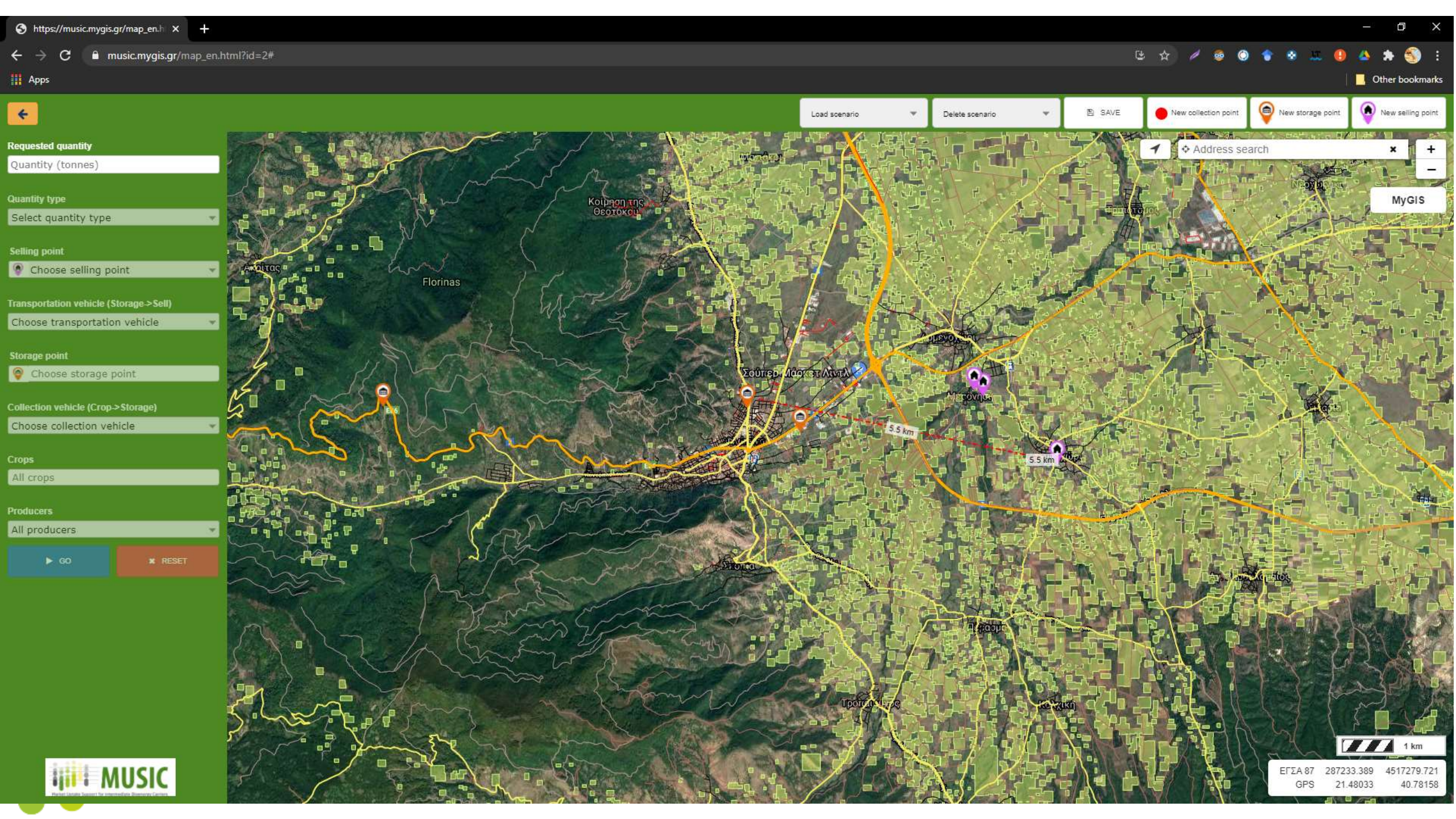

MUSIC
MyGIS - Florina R.U.
Super Users
Criteria
Search
Legend
0
Refresh
Table
At a glance
Support
DB browser
Logout
Legend
Collection poi
Sell points
Storage point
Road network
Crops
Irrigated corn
Industrial production pe...
Other grain
Other crops - forest trees
Other vineyards for tabl...
Pome fruits
Other crops - arborace...
Stone fruits
Oilseeds
Husk fruits
Energy crops
Cotton
Certified cultivation oliv...
Vineyards for wine pro...
Wheat
Crops (overvi
Municipalities
Florina Regio
Vehicle specif
Greek Cadastre
Google Roadmap
Export
Address search
Layer: Crops
Name: Wheat
Area (stremma): 5.951
Annual biomass (tn): 0.833
Annual charcoal (tn): 0.595
1 km
ΕΓΣΑ 87 304694.501 4501632.878
GPS 21.69196 40.64507

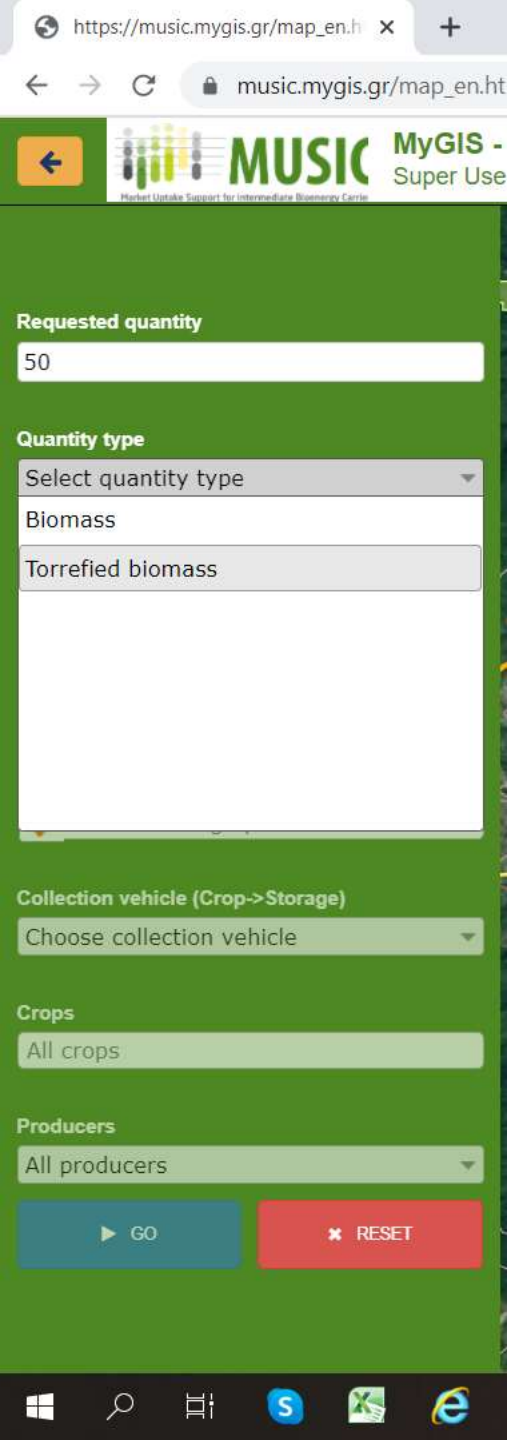
Selection of crops and vehicles

cropcode	biomass_cal_value	biomass_annual_ef	crop_gr	crop_en	id	char_cal_value	char_annual_ef
45.2	18330	0.21	Λοιπές καλλιέργειες - δενδρώδεις	Other crops - arboraceous	4	20070	0.17
36.3	19130	0.42	Λοιποί αμπελώνες για επιτραπέζια χρήση	Other vineyards for table use	8	20950	0.24
36.2	19130	0.42	Λοιποί αμπελώνες για παραγωγή οίνου	Vineyards for wine production	9	20950	0.24
1	17570	0.12	Σιτάρι	Wheat	11	20910	0.09
12	17770	0.31	Βαμβάκι	Cotton	15	21150	0.26
15	20080	0.13	Ελαιώνες πιστοποιημένης ελαιοκαλλιέργειας	Certified cultivation olive grove	16	21990	0.11
16	16090	0.14	Ενεργειακές καλλιέργειες	Energy crops	17	19140	0.12
2	16900	0.12	Λοιπά σιτηρά	Other grain	12	20110	0.09
4	16090	0.14	Ελαιούχοι σπόροι	Oilseeds	13	17700	0.12
21	19460	0.5	Καρποί με κέλυφος	Husk fruits	19	21410	0.43
49	20250	0.21	Λοιπές καλλιέργειες - δασικά δέντρα	Other crops - forest trees	5	22170	0.17
66	19650	0.53	Πυρηνόκαρπα	Stone fruits	6	21610	0.27
67	19220	0.41	Μηλοειδή	Pome fruits	7	21040	0.7
20.2	19960	0.53	Ροδακινιές μεταποίησης	Industrial production peaches	1	21860	0.42
3.1	20080	0.4	Αραβόσιτος ποτιστικός	Irrigation corn	2	23890	0.14

Vehicle specifications is not a geographic layer

Can carry Charcoal - Powder: YES	Service cost (€/km): 0.09
Maximum payload (tn) Charcoal - Pellets: 13.00	Can carry Biomass - Rectangular bale: YES
Vehicle name: Scania R164L480	Can carry Biomass - Bulk: YES
Capacity (m3): 20	Can carry Biomass - Round bale: YES
Average speed (km/hr): 65	Can carry Biomass - Big bags: YES
Work cost (€/hr): 15.00	Vehicle type: Truck
Load/unload time (hrs): 2.00	userID: 0
Fuel cost (€/l): 1.20	Maximum payload (tn): 20.00
Fuel consumption (l/km): 0.15	Maximum payload (tn) Biomass - Rectangular bales: 5.54
Payback €/year (vehicle): 0	Maximum payload (tn) Biomass - Round bales: 7.99
Payback €/year (trailer): 5500	Maximum payload (tn) Biomass - Bulk: 7.00
Year expenses (€): 1000	Maximum payload (tn) Biomass - Big bags: 6.89
	Maximum payload (tn) Charcoal - Powder: 5.40


https://music.mygis.gr/map_en.h
music.mygis.gr/map_en.html?id=2#
Apps
Other bookmarks
Load scenario
Delete scenario
SAVE
New collection point
New storage point
New selling point
Requested quantity
Quantity (tonnes)
Quantity type
Select quantity type
Selling point
Choose selling point
Transportation vehicle (Storage->Sell)
Choose transportation vehicle
Storage point
Choose storage point
Collection vehicle (Crop->Storage)
Choose collection vehicle
Crops
All crops
Producers
All producers
GO
RESET
Address search
MyGIS
Florinas
5.5 km
5.5 km
1 km
ΕΓΣΑ 87 287233.389 4517279.721
GPS 21.48033 40.78158
MUSIC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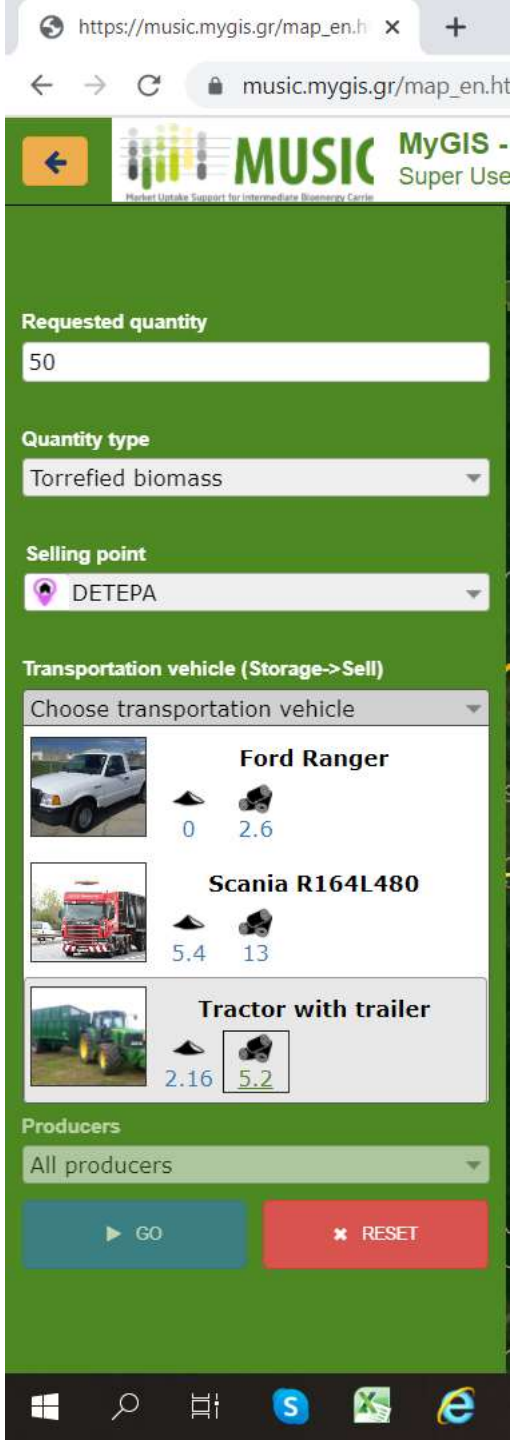
MUSIC
MyGIS -
Super Use
Requested quantity
50
Quantity type
Select quantity type
Biomass
Torrefied biomass
Collection vehicle (Crop->Storage)
Choose collection vehicle
Crops
All crops
Producers
All producers
GO
RESET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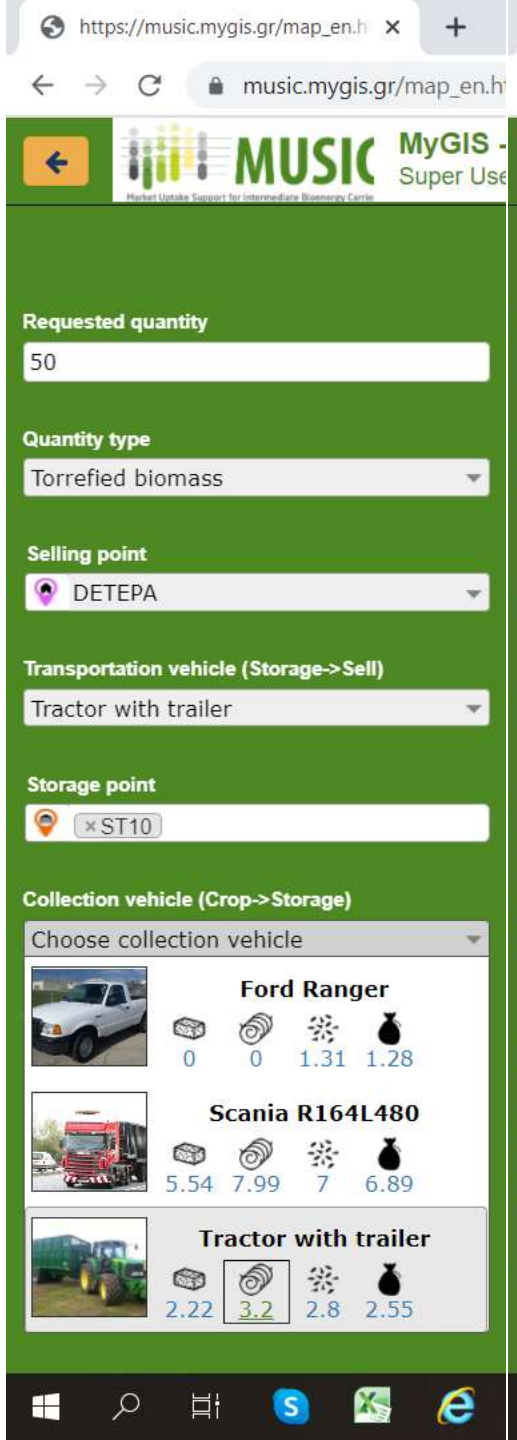
MUSIC
MyGIS -
Super Use
Requested quantity
50
Quantity type
Torrefied biomass
Selling point
DETEPA
Transportation vehicle (Storage->Sell)
Choose transportation vehicle
Ford Ranger
0
2.6
Scania R164L480
5.4
13
Tractor with trailer
2.16
5.2
Producers
All producers
GO
RESET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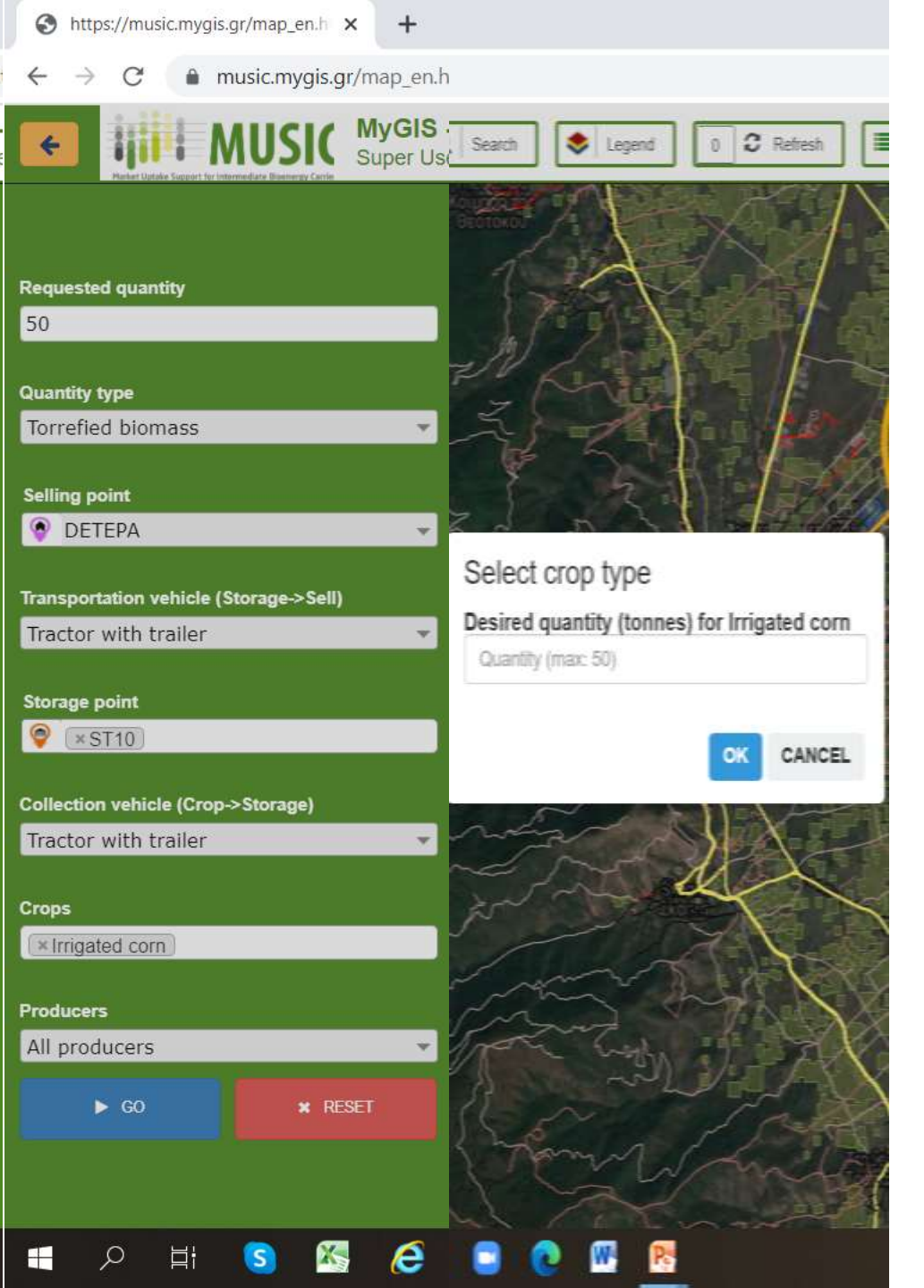
MUSIC
MyGIS -
Super Use
Requested quantity
50
Quantity type
Torrefied biomass
Selling point
DETEPA
Transportation vehicle (Storage->Sell)
Tractor with trailer
Storage point
ST10
Collection vehicle (Crop->Storage)
Choose collection vehicle
Ford Ranger
0
0
1.31
1.28
Scania R164L480
5.54
7.99
7
6.89
Tractor with trailer
2.22
3.2
2.8
2.55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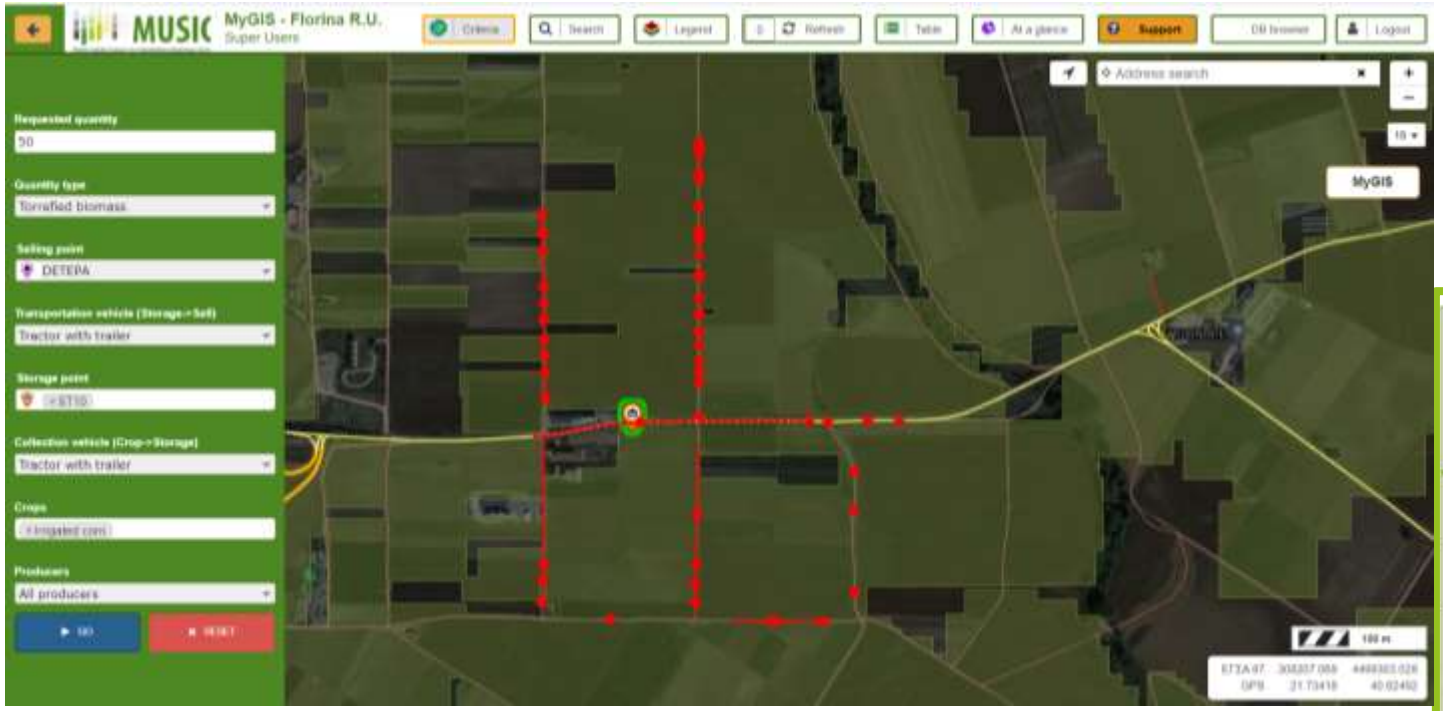
MUSIC
MyGIS -
Super Us
Search
Legend
Refresh
Requested quantity
50
Quantity type
Torrefied biomass
Selling point
DETEPA
Transportation vehicle (Storage->Sell)
Tractor with trailer
Storage point
ST10
Collection vehicle (Crop->Storage)
Tractor with trailer
Crops
Irrigated corn
Producers
All producers
GO
RESET
Select crop type
Desired quantity (tonnes) for Irrigated corn
Quantity (max: 50)
OK
CANCEL



The model output consists of the **total biomass transportation cost** (as a sum of fixed, working, fuel and service cost), and the total **distance, routes and time for the specific collection-storage-sale supply chain**.

Individual costs for the two stages: (Field->Storage Point Storage Point ->Selling Point)	Total Cost
Type of the vehicle selected	Collection-storage trips
Transport method	Collection-Storage total (km)
Total quantity (t)	Storage - Sell trips (km)
Routes	Storage Sell total (km)
Total distance (km)	Total routes
Distance based-time (hours)	Total distance (km)
Transport time (hours)	Total time (hours)
Fixed cost (€/h)	Total cost (€)
Work cost (€/h and €/t)	Grand total per ton (€)
Fuel cost (€/h and €/t)	Grand total per MJ (€)
Service cost (€/h and €/t)	
Energy content (MJ)	
Cost (€)	
Cost per ton (€/t)	
Cost per MJ (€/MJ)	

Results

Collection -> Storage null(ID: 12)

Vehicle	Tractor with trailer
Transport method	Round bales
Total quantity (tn)	51.89
Routes	17
Distance (km)	44.42
Distance-based time (hours)	1.62
Transport time (hours)	23.83
Fixed cost (€/hour)	1.70
Work cost (€/hour)	10.00
Fuel cost (€/km)	0.26
Service cost (€/km)	0.03
Fixed cost (€/tn)	0.81
Work cost (€/tn)	4.77
Fuel cost (€/tn)	0.23
Service cost (€/tn)	0.03

Storage null(ID: 12) -> Sell

Vehicle	Tractor with trailer
Transport method	Pellets
Total quantity (tn)	51.89
Routes	10
Distance (km)	52.16
Distance-based time (hours)	1.04
Transport time (hours)	6.04
Fixed cost (€/hour)	1.70
Work cost (€/hour)	10.00
Fuel cost (€/km)	0.26
Service cost (€/km)	0.03
Fixed cost (€/tn)	0.21
Work cost (€/tn)	1.21
Fuel cost (€/tn)	0.27
Service cost (€/tn)	0.03

Total

Collection-storage trips	17
Collection-storage total km	44.42
Storage-sell trips	10
Storage-sell total km	52.16
Total routes	27
Total distance (km)	96.58
Total time (hours)	29.87
Total cost (€)	377.94
Grand total per tonne (€)	7.56

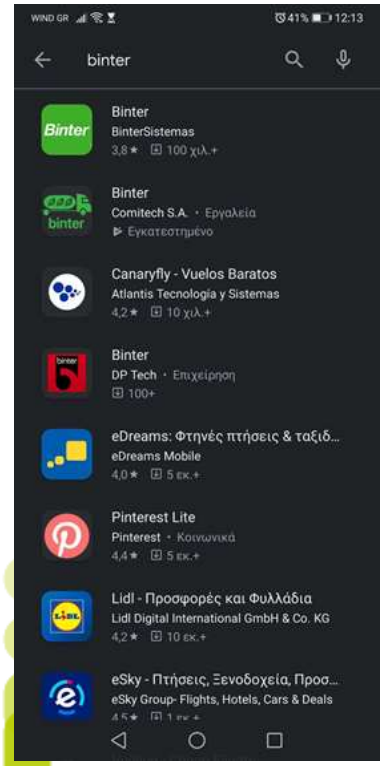
Collection point	Field	Storage	Crop	Annual biom...	Annual charc...	Total quantity
77564	63212	12	Irrigated corn	0.424	0.301	0.424
77379	62962	12	Irrigated corn	1.224	0.867	1.648
77213	62752	12	Irrigated corn	1.161	0.822	2.809
82488	71399	12	Irrigated corn	1.149	0.814	3.958
82728	71759	12	Irrigated corn	1.220	0.864	5.178
77604	63264	12	Irrigated corn	1.172	0.830	6.350
77558	63206	12	Irrigated corn	0.476	0.337	6.826
74957	58827	12	Irrigated corn	0.588	0.417	7.414
82645	71641	12	Irrigated corn	1.171	0.829	8.585
77596	63254	12	Irrigated corn	1.171	0.830	9.756
77376	62959	12	Irrigated corn	1.216	0.861	10.972
77559	63207	12	Irrigated corn	0.279	0.198	11.251
77591	63249	12	Irrigated corn	0.630	0.446	11.881
69365	49426	12	Irrigated corn	1.125	0.797	13.006
74956	58826	12	Irrigated corn	1.233	0.873	14.239
78915	65520	12	Irrigated corn	0.668	0.473	14.907
77359	62938	12	Irrigated corn	1.166	0.826	16.073
77489	63120	12	Irrigated corn	1.173	0.831	17.246
77562	63210	12	Irrigated corn	1.204	0.853	18.450
77594	63252	12	Irrigated corn	0.645	0.457	19.095
77560	63208	12	Irrigated corn	1.181	0.836	20.276

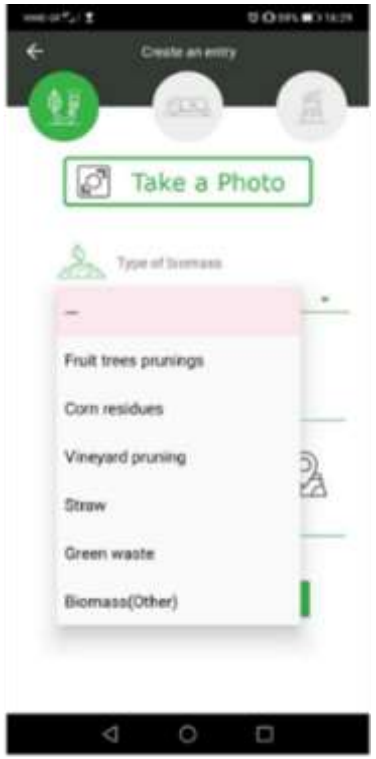
Binter app

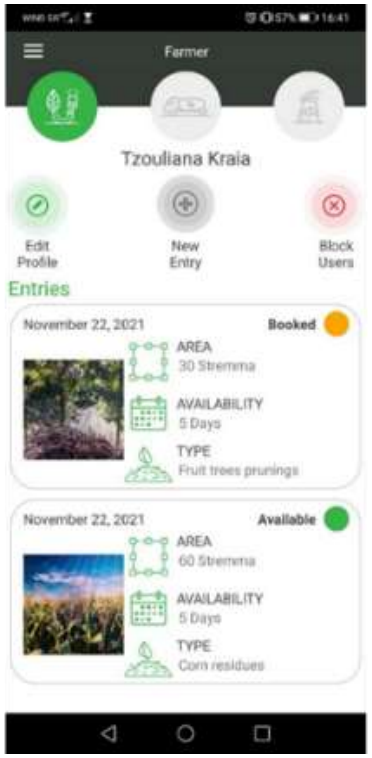
An interactive platform for mobilising feedstock towards IBC production for facilitating regional biomass trade

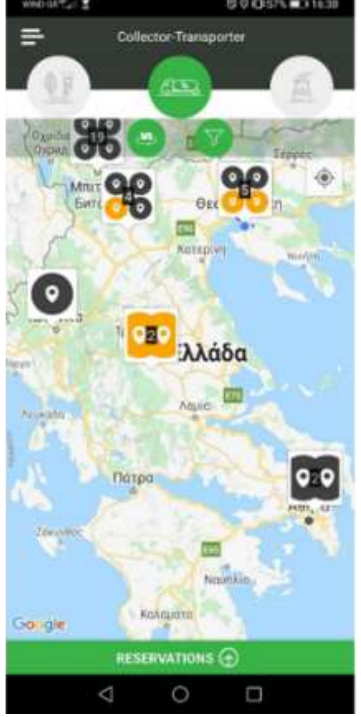
A smart phone app tool called ‘binter’, through which farmers/bio-feedstock producers advertise their available biomass by auto-matically uploading it in data bases so that IBC plants can then organize the feedstock logistics towards collection of the desired types of biomass.

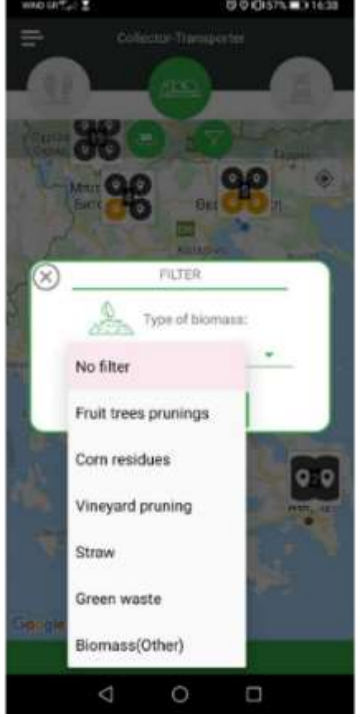
Farmer

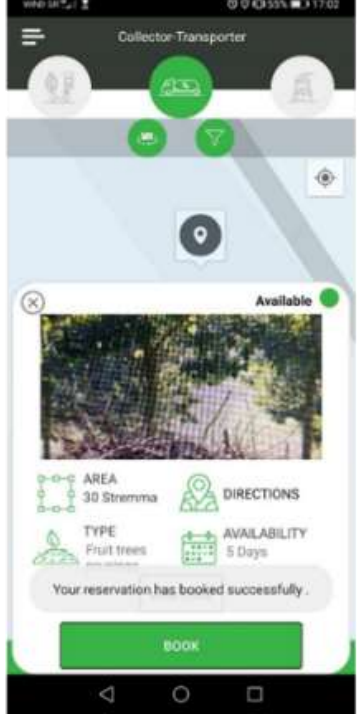


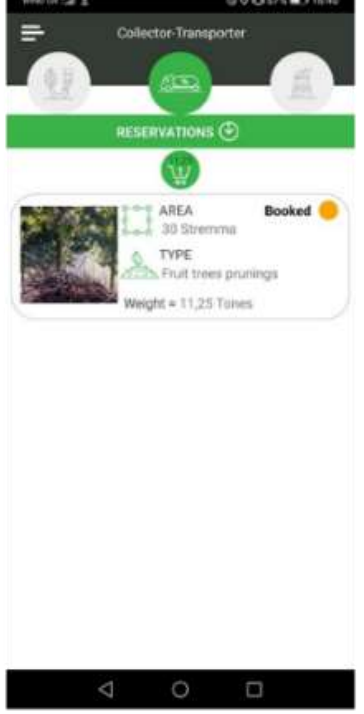








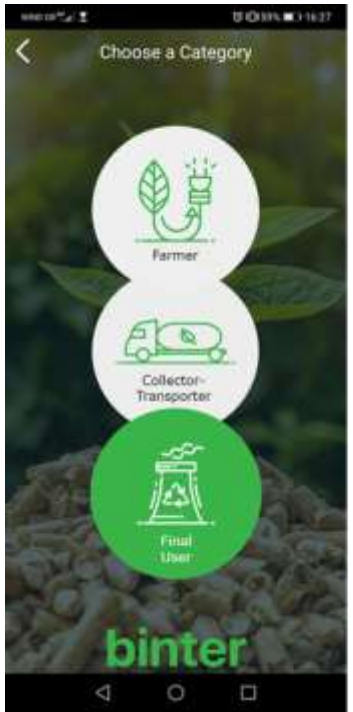


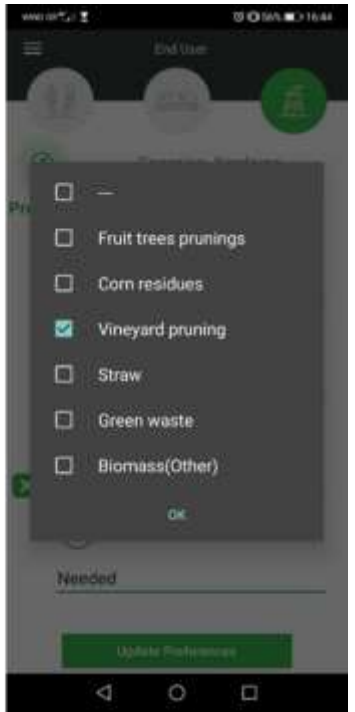


MUSIC

Collector/transporter

End user





Binter app- online environmental data and Green certificate tool

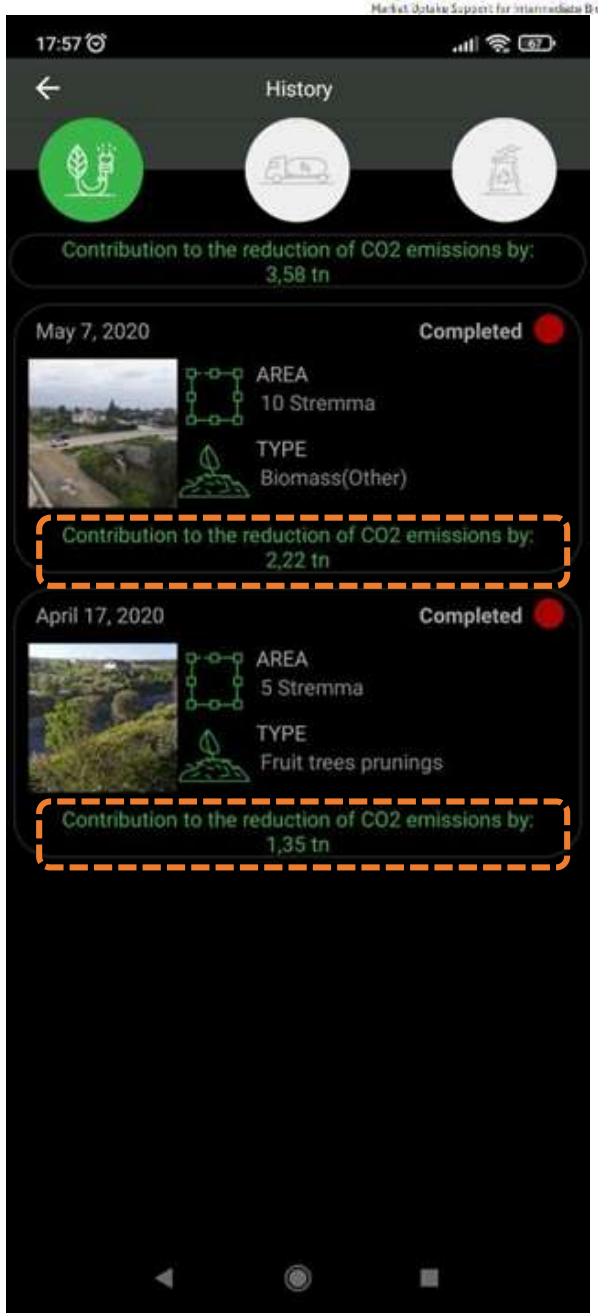
Binter app was expanded to include a simplified estimation of potential emissions reductions. An online environmental data and green certificate tool is developed by CERTH, based on RED II methodology and principles, SimaPro v9.1 software and literature data.

Thus **Binter app determines**:

- biomass quantities in tonnes,
- moisture con-tent in % wet based,
- energy content in MJ/kg and,
- distance from the DETEPA district heating plant in km,
- the total GHG from the use of each biomass type,

(in g CO2 eq/MJ of produced heat)

- and the GHG emissions savings in %.



CONCLUSIONS

- **Torrefaction** can **homogenize** biomass feedstocks with **diverse characteristics → standardization → contractualization.**
- The **MUSIC-MyGIS model**
  - is a GIS application that contains cartographic backgrounds, administrative layers, road network, storage and selling points, land use maps and data bases with data on crop types, yields and energy potentials, biomass forms and transport means. Data are used in algorithms, so that the interested party can calculate not only the final cost, but also the costs of the intermediate phases, until the final delivery to the end user.
  - Logistics are processed in two stages: **Field → storage/torrefaction unit → end user**.
  - Total routes, distances, and times as well as total costs, costs per ton and per MJ for each stage are calculated.
- **The binter app**
  - A smart phone app tool to support the market development from mobilisation of feedstock towards IBC production and use.
  - Farmers/biomass producers advertise their available biomass by automatically uploading it in a data bases that IBC plants can then organize the feedstock logistics towards collection of the desired types of biomass.
  - Photographs of the available biomass together with the geographic, quantity estimate and possible other relevant data are upload on the platform, so that IBC producers can organise efficient collection.
- **Synergies** – farmers, transporters, end-users → **Mobilization** of **unexploited** quantities → **Security** of supply.

Thank you for your attention!

For more info:

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WWW.MUSIC-H2020.EU

#MUSIC_H2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 857806.

MUSIC

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