Delivery of sustainable supply of non-food biomass to support a resource-efficient Bioeconomy in Europe

S2Biom summer school, Athens, Greece, 17-20 May, 2016

Session 5: Biomass logistics

The main logistical components and logistic concepts (WP3)

(demo of s2biom tools & hands on session)

Presenter: Igor Staritsky, DLO - Alterra

This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°608622.

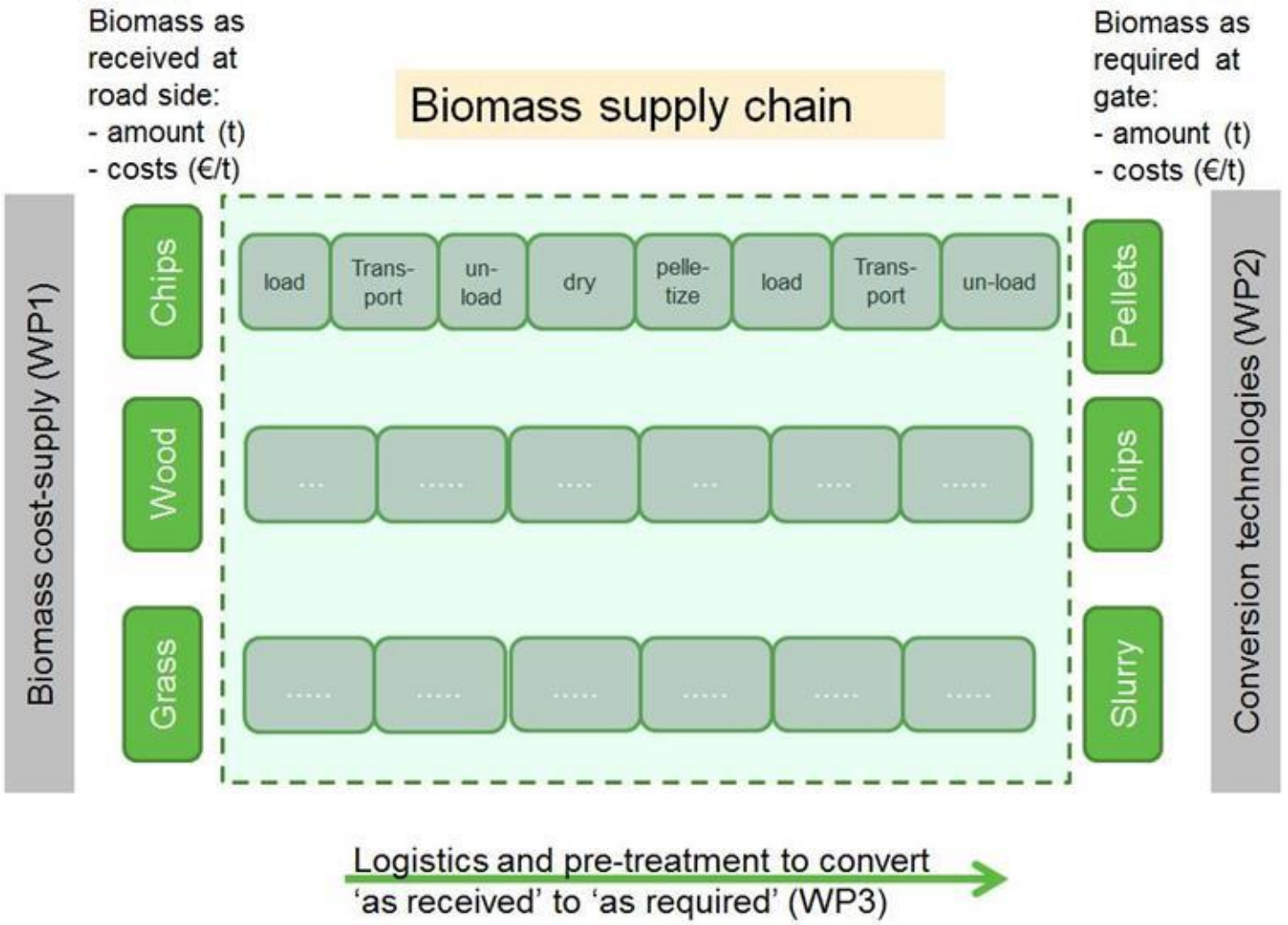
Objectives & tasks
WP3: Logistics

- to identify and characterise the main logistical components (such as storage, pre-treatment and transportation technologies) (Task 3.1)
- to identify and assess existing and develop new logistical concepts (e.g. biomass yards) to optimize sustainable non-food biomass feedstock delivery chains (Task 3.2)
- to translate theoretical logistical concepts to specific cases, and design the most promising logistic supply-chains for cases at local, regional and pan-European level (Task 3.3)

Outline

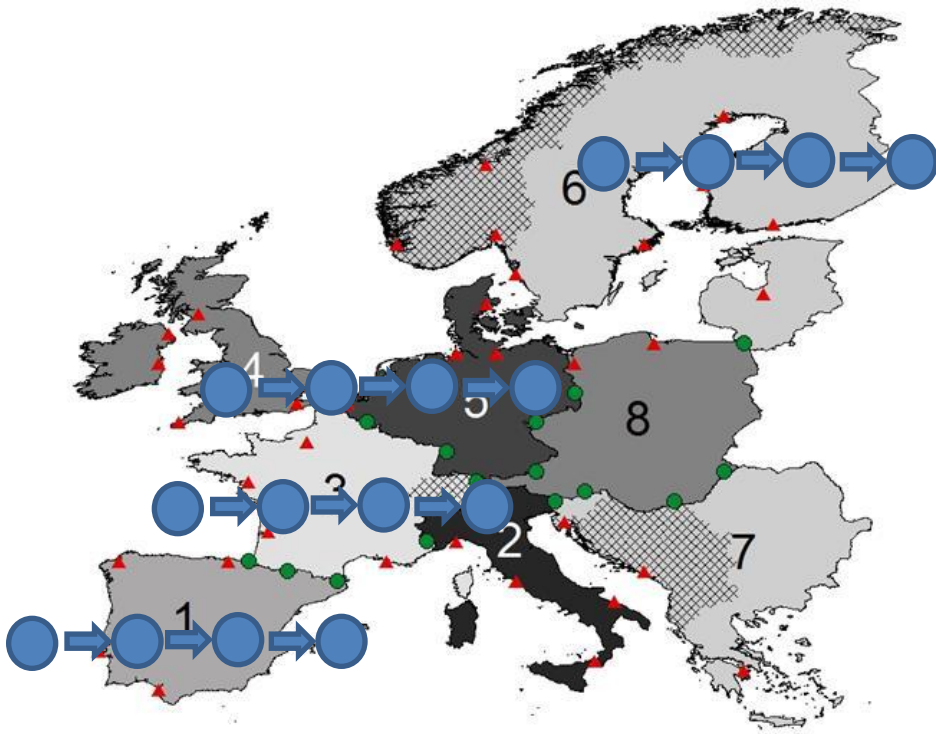
- **Biomass supply chains**
- **Bewhere v.s. LocaGIStics**
- **Walk through LocaGIStics**

Biomass supply chains

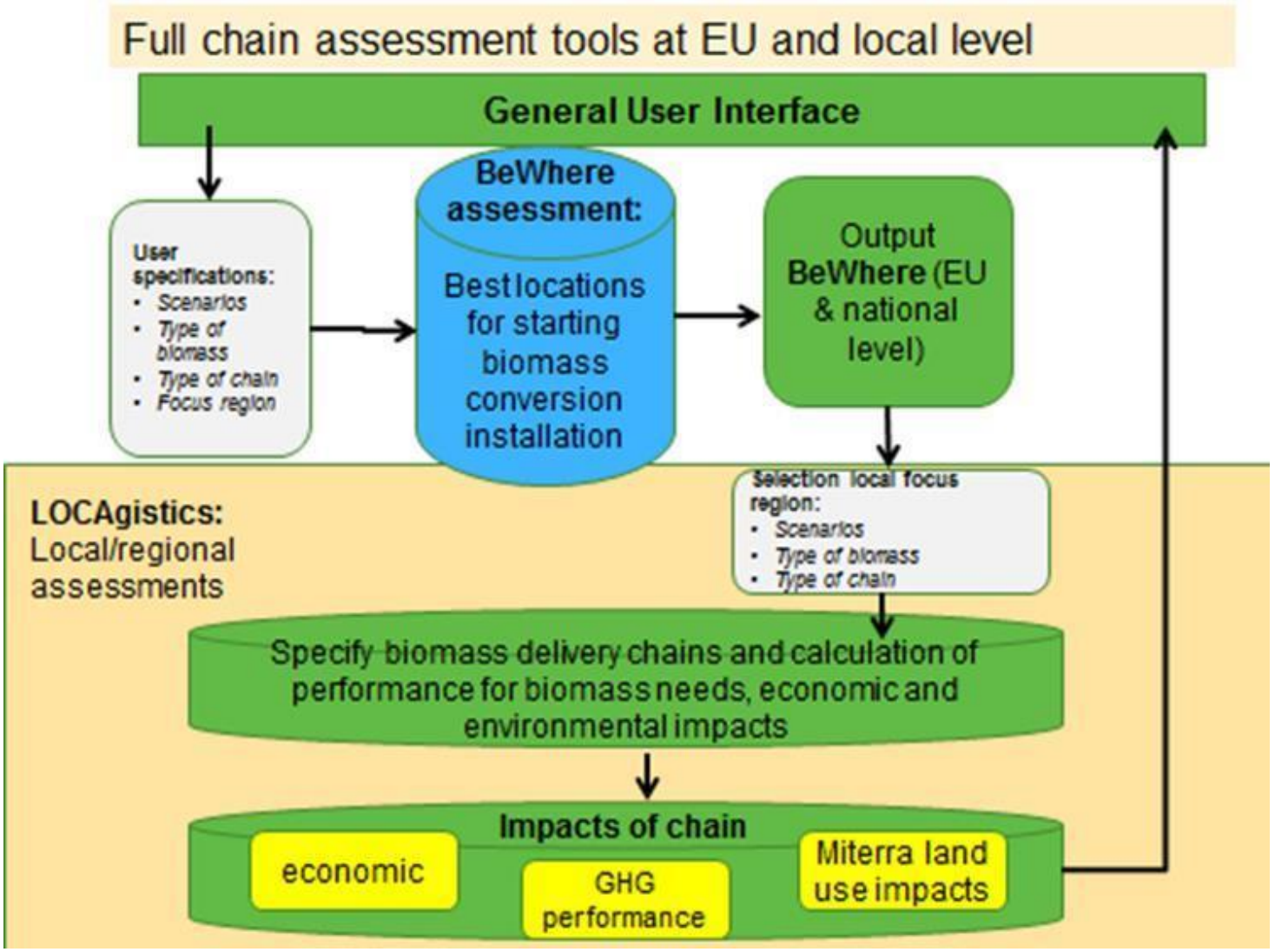


From component to case study

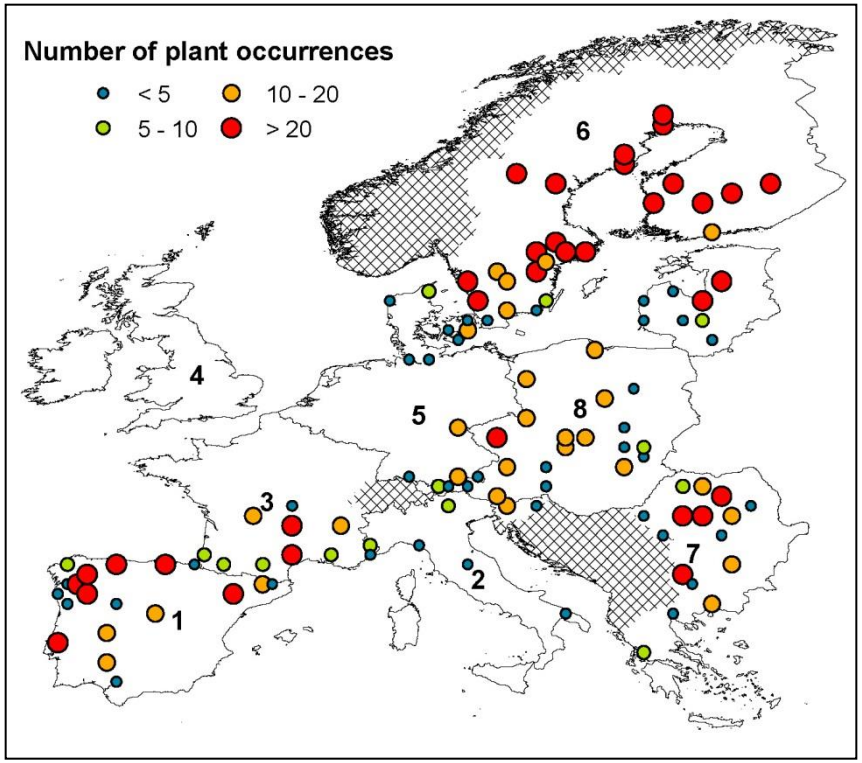
- **logistical component:**
- **logistical concept/chain:**
- **logistical concepts will be translated to**
  1. EU level (BeWhere)
  2. regional advanced case studies (LocaGIStics):
     - Finland (Infres)
     - France (LogistEC)
     - Spain (Europruning)

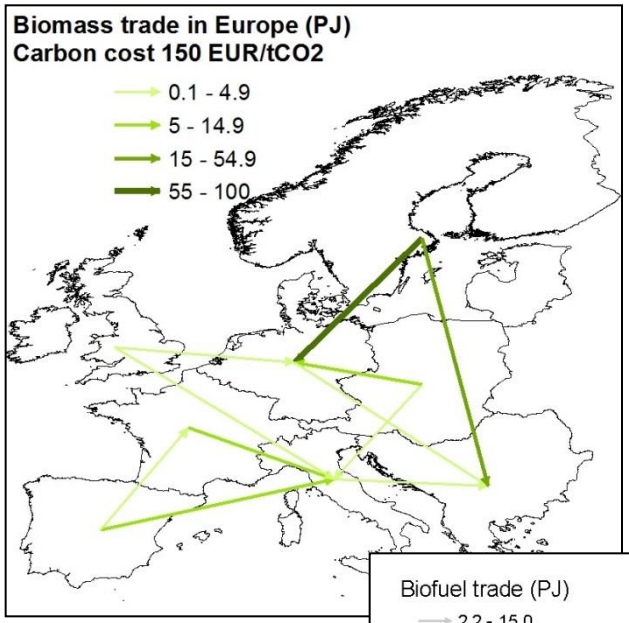


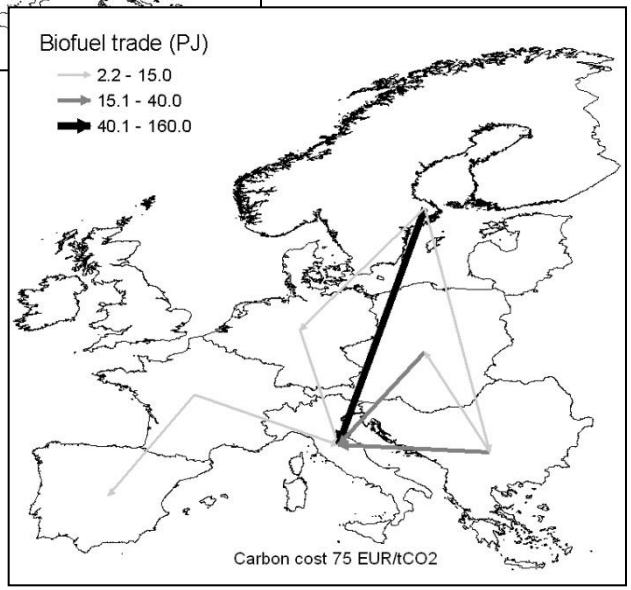
Two tools for assessments: BeWhere & Locagistics



Output BeWhere







Source: Leduc et al., 2013
International Institute for Applied Systems Analysis (IIASA)

Regional level: LocaGIStics

- **LocaGIStics is a visual, interactive tool for specification and assessment of biomass value chains**
- **it aims at regional level**
- **link with BeWhere model on an EU-/country level (output transferred to LocaGIStics)**
- **first developed in Dutch national ‘ME4’ project and now further developed for S2Biom**

Specify configuration case study 1

- **country, area of interest, case, variant**

Countries	Areas of interest
France	Burgundy

Cases
Burgundy straw and miscanthus

Variants

Name	Financial profit	Energy profit	Net GHG avoided	
empty	0	0	0	
1 pp, 1 icp	3,658,439	440,685	42,197	

Specify configuration case study 2

- **biomass type**

Biomass types			
Name	Availability (%)	Field - ICP moisture content (%)	ICP - PP moisture content (%)
Straw	33	14	9
Miscanthus	100	15	10

Specify configuration case study 3

- power plant
- intermediate collection point

Power plants

Name	Size (ton DM)	Amount (ton DM)	Financial profit	Energy profit	Net GHG avoided
pp 1	30,000	30,481	3,658,439	440,685	42,197

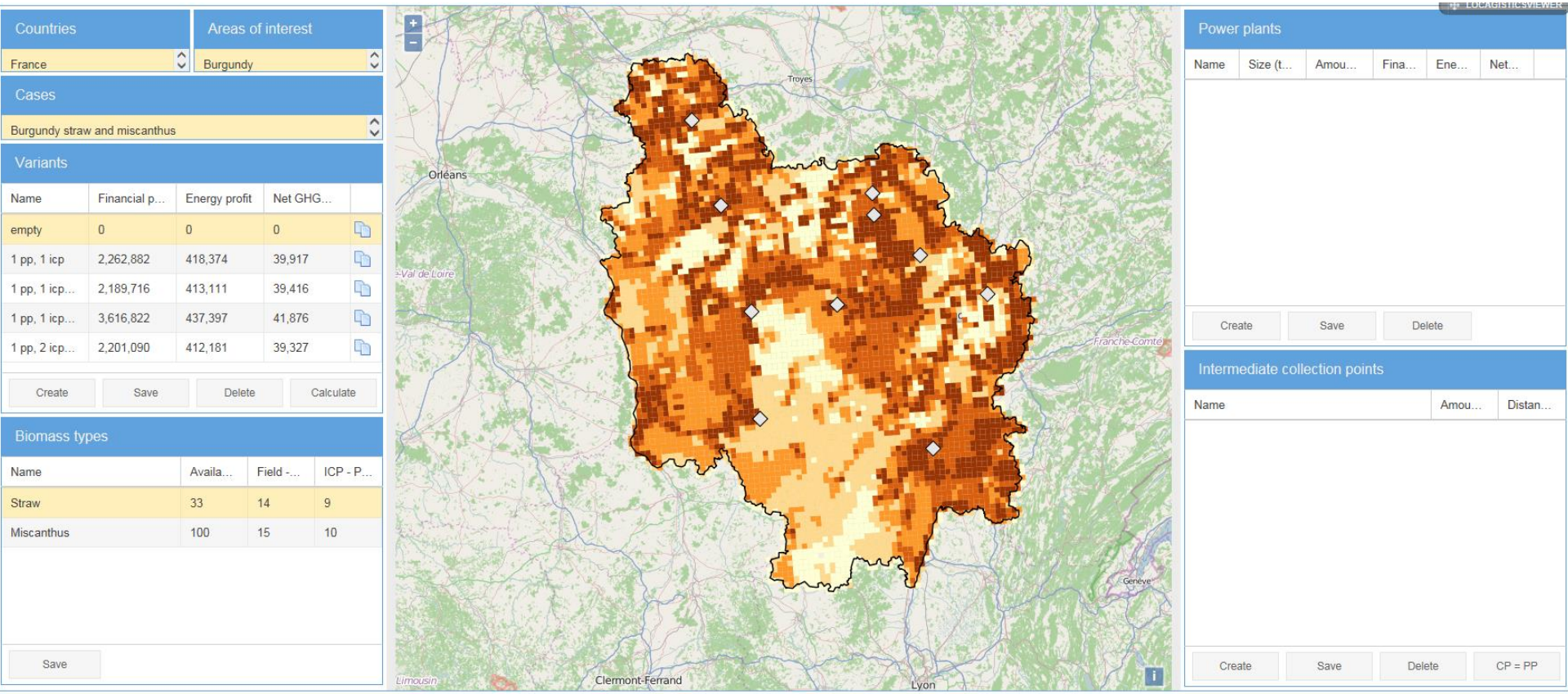
Intermediate collection points

Name	Amount (ton DM)	Distance (ton km.)
icp 1.1	22,626	109,013
ipc 1.2	7,855	50,479

Regional level: LOCAgistics

- position the power plant on the map
- position one or two intermediate collection points on the map
- start calculation: GIS based ‘peeling heuristic’ determines biomass used (ton dm) and transport distances (ton.km) based on biomass availability maps

Suggested locations BeWhere

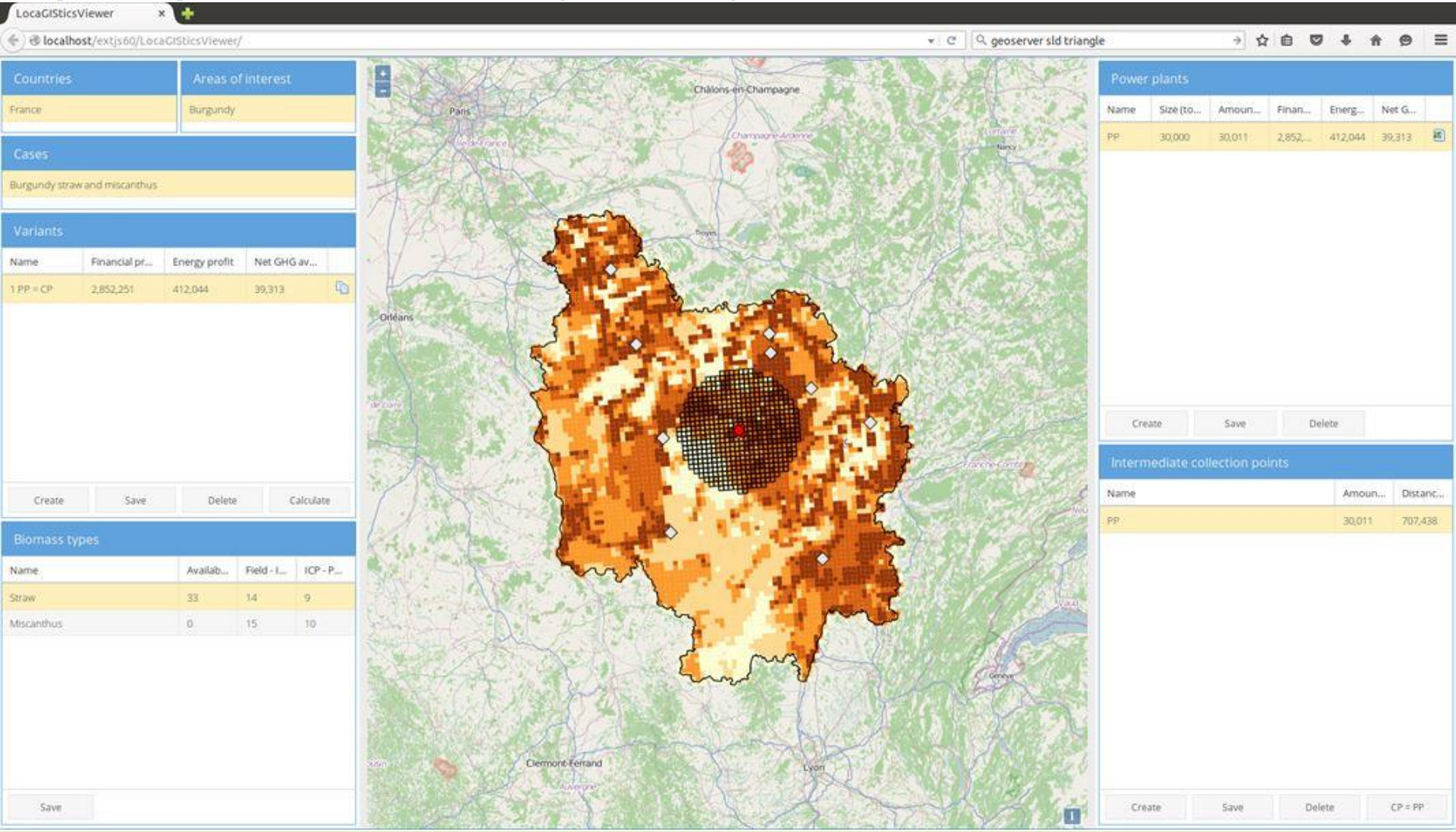


Four variants

- **powerplant & no biomass yard; only straw**
- **powerplant & no biomass yard; straw & Miscanthus**
- **powerplant & one biomass yard; straw & Miscanthus**
- **powerplant & two biomass yards; straw & Miscanthus**

Variant 1

powerplant & no biomass yard; only straw

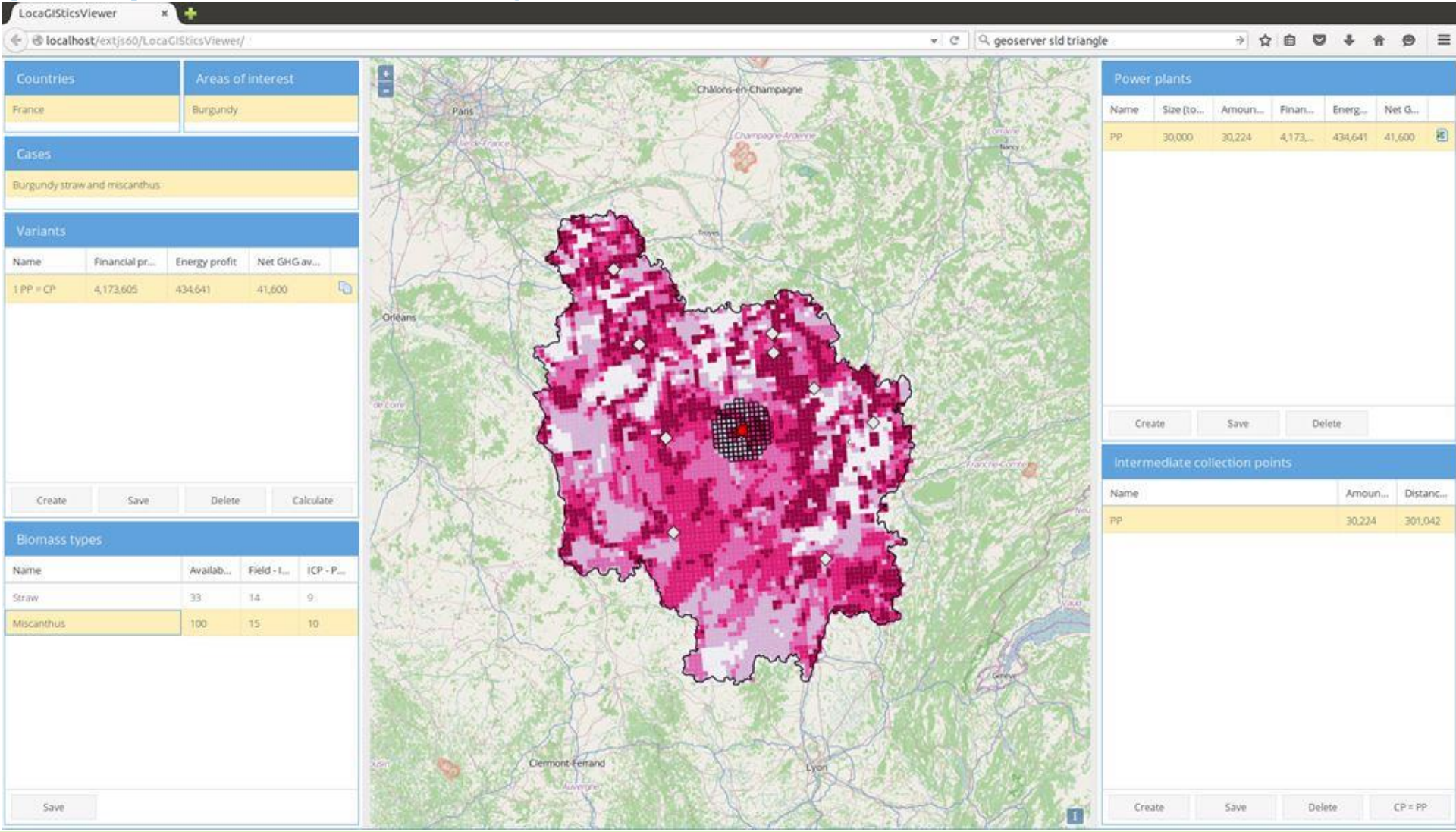


Discussion

- yellow map is available straw
- only 33% straw was available
- more or less biomass available will influence the size of the collection circle

Variant 2

powerplant & no biomass yard; straw & Miscanthus

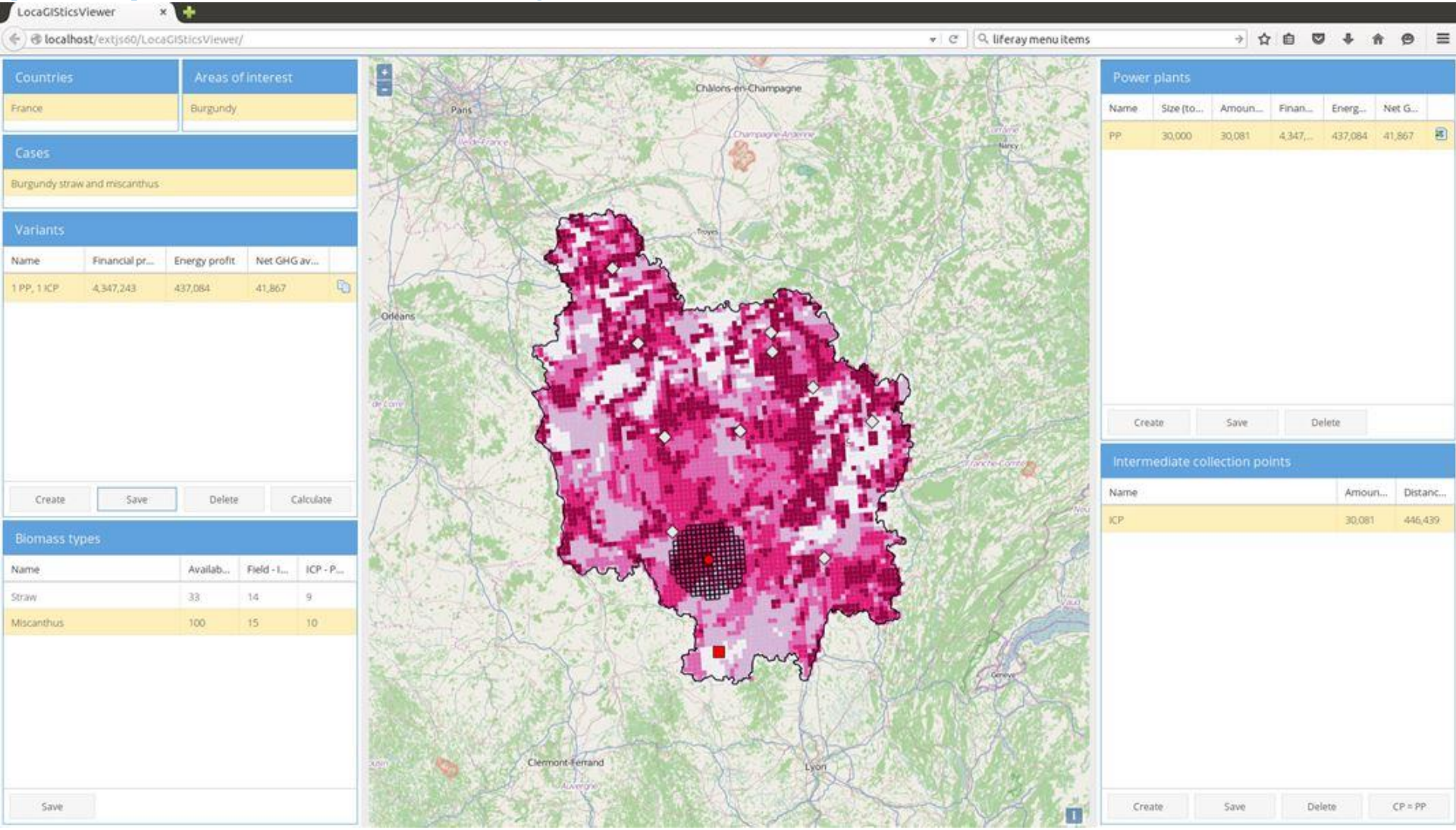


Discussion

- different map is shown: purple for Miscanthus
- smaller supply circle, because Miscanthus now also available at closer distance
- notice that calculation results are different (e.g. profit)

Variant 3

powerplant & one biomass yard; straw & Miscanthus

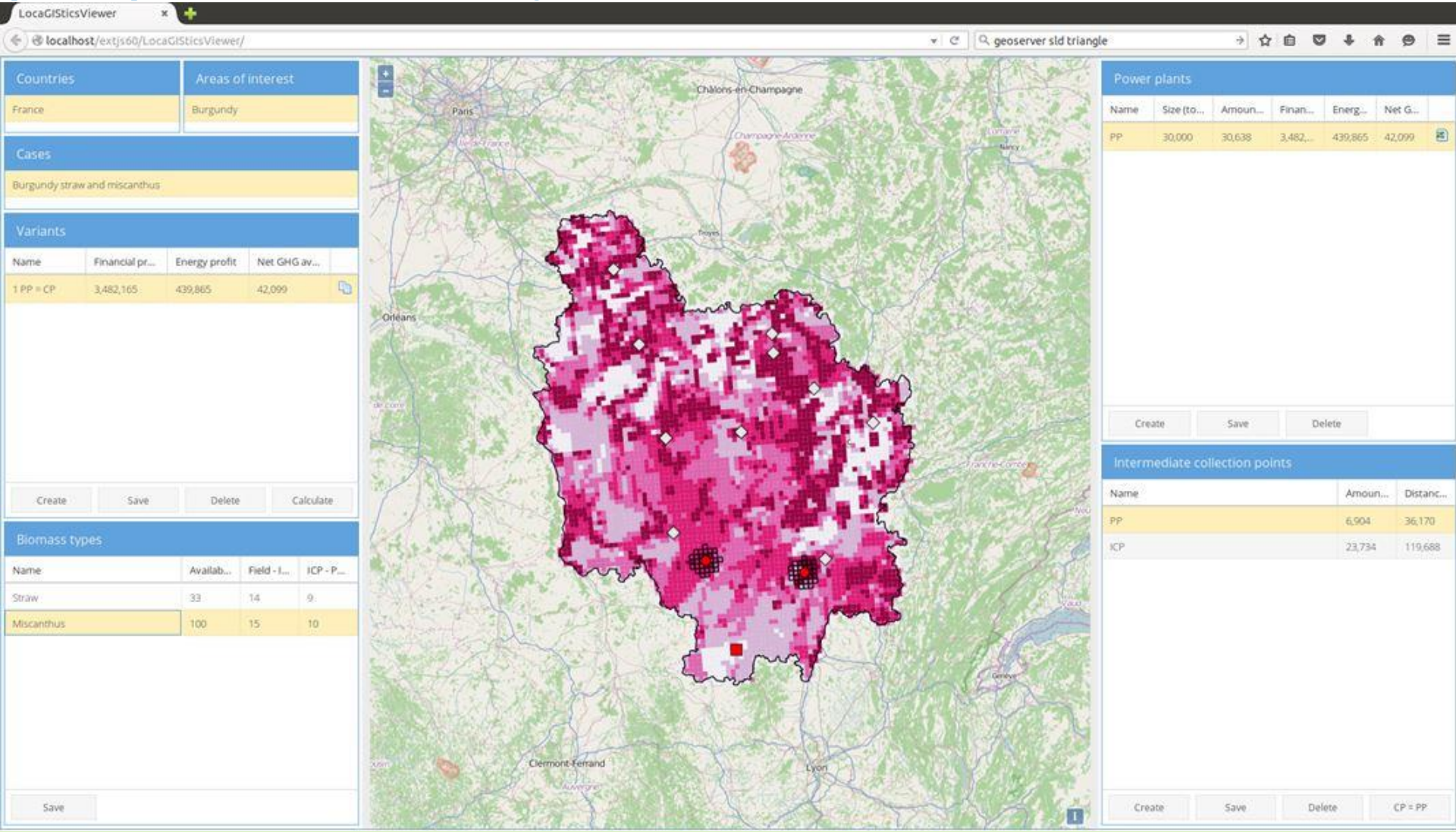


Discussion

- location powerplant and intermediate collection point separated
- intermediate collection point near to biomass sources

Variant 4

powerplant & two biomass yards; straw & Miscanthus



Discussion

- two intermediate collection points
- for this size of the power plant two is probably too much (very small collection circle
- however this can be compared on costs, energy production and avoided GHG emissions

Regional level: LOCAgistics

- **excel sheet calculates economics, energy production and avoided GHG emissions**

Variants

Name	Financial profit	Energy profit	Net GHG avoided
empty	0	0	0
1 pp, 1 icp	2,262,882	418,374	39,917
1 pp, 1 icp sep	2,189,716	413,111	39,416
1 pp, 1 icp misc sep	3,616,822	437,397	41,876
1 pp, 2 icp sep	2,201,090	412,181	39,327

LOCAgistics cost calculation method

- **LOCAgistics current cost calculation method based on Bioloco (logistical optimization model): 'simple chain calculation' in excel:**
  - specify basic chain data (biomass, storage, transport, loading/unloading, pre-treatment and conversion)
  - weight/volume restrictions of transport means
  - total transport distance calculated by 'biomass search procedure'
  - then overall revenues and costs are calculated

LOCAgistics Basic chain data

Input basic	yellow = calculated	
Biomass basic	**B1**	**B2**
name	Straw	Miscanthus
Higher Heating value [GJ/ton dm]	17.00	18.50
initial moisture content [kg moisture/kg total]	16%	15%
biomass costs at roadside [euro/ton dm]	45.00	8.82
energy use biomass at roadside [GJ/ton dm]	0.50	0.84
Form basic	**F1**	**F2**
description form	bales	pellets
bulk density [kg dm/m3]	400	650
specific volume [m3/ton dm]	2.50	1.54
Storage basic	**S1**	**S2**
name	open air storage	covered storage
costs [euro/m3.month]	0.23	0.92
energy use [MJ/m3.month]	0.00	0.00
Transport basic	**FI to IC**	**IC to PP**
name	truck	walking floor
maximum volume [m3]	80	92.3
maximum weight [ton]	26.6	28
variable vehicle costs per driven km [euro/km]	3.26	3.10
fixed vehicle costs per load [euro]	0.00	0.00
transport energy [MJ/km]	4.48	4.48

LOCAgistics Basic chain data

Transport basic	FI to IC	IC to PP
name	truck	walking floor
maximum volume [m3]	80	92.3
maximum weight [ton]	26.6	28
variable vehicle costs per driven km [euro/km]	3.26	3.10
fixed vehicle costs per load [euro]	0.00	0.00
transport energy [MJ/km]	4.48	4.48
Loading/unloading basic	**L1**	**L2**
transport type being (un)loaded	truck	walking floor
loading costs [euro/m3]	0.63	0.31
unloading costs [euro/m3]	0.50	0.25
loading energy [MJ/m3]	3.13	3.00
unloading energy [MJ/m3]	3.13	3.00
Pretreatment	**P1**	**P2**
name	pelletising	grinding
output form	pellets	powder
pretreatment costs [euro/m3]	22.80	9.74
pretreatment energy [MJ/m3]	4.00	6.00
drying costs [euro/ton moisture]	0.00	0.00
drying energy [MJ/ton moisture]	0.00	0.00

LOCAgistics Basic chain data

Conversion	C1
name	combustion, grate boiler 5MWe, 10 MWth
net energy returns electricity [usable GJ/GJ input]	25.00%
net energy returns heat [usable GJ/GJ input]	60.00%
evaporation energy moisture [GJ/ton moisture]	2.256
capacity input [ton dm/month]	2,500
working hours [per month]	583
fixed costs plant + conversion [euro /year]	625,000.00
variable costs conversion [euro/ton dm input]	30.00
energy use [GJ/m3]	0.0002
emission CO2 [mg/Nm3]	0
emission NOx [mg/Nm3]	475
emission SO2 [mg/Nm3]	0
emission dust [mg/Nm3]	3,000

Revenues	PP
price electricity [euro/GJ]	53.61
price heat [euro/GJ]	3.17

Legenda

B1 = biomass type 1; B2 = biomass type 2

IC= intermediate collection point; PP = power plant

FI=Field

LOCAgistics chain design

Input chain	yellow = calculated organge = fixed				
Chain					**Formula**
case description	Burgundy				
calculation number	1				
biomass chain name	bioenergy				
Chain design	**B1 to IC1**	**B1(IC1) to PP**	**B2 to IC1**	**B2(IC1) to PP**	
	Straw to [default nan	Straw ([default name	Miscanthus to [defau	Miscanthus ([default	name]) to [default name]
Biomass					
biomass type	Straw	Straw	Miscanthus	Miscanthus	taken from Input basic
origin location	Field	IC1	Field	IC1	fixed
destination location	IC1	PP	IC1	PP	fixed
description form	bales	pellets	bales	pellets	taken from Input basic
bulk density [kg dm/m3]	400	650	400	650	taken from Input basic
specific volume [m3/ton dm]	2.50	1.54	2.50	1.54	1000/bulk density
biomass shipped fresh [ton fresh]	4,285	4,049	31,054	29,329	biomass dry matter / (100 - initial moisture content) * 100
moisture content [kg moisture/kg total]	14%	9%	15%	10%	only original biomass moisture content inserted, other manual
biomass shipped dry [ton dm]	3,685	3,685	26,396	26,396	transfer from LOCAgistics
Storage					
name	open air storage	covered storage	open air storage	covered storage	taken from Input basic
costs [euro/m3.month]	0.23	0.92	0.23	0.92	taken from Input basic
energy use [MJ/m3.month]	0.00	0.00	0.00	0.00	taken from Input basic
average storage time [month]	4.5	4.5	4.5	4.5	default that can be changed
Transport basic					
name	truck	walking floor	truck	walking floor	taken from Input basic
maximum volume [m3]	80	92	80	92	taken from Input basic
maximum weight [ton]	27	28	27	28	taken from Input basic
variable vehicle costs per driven km [euro/km]	3.26	3.10	3.26	3.10	taken from Input basic
fixed vehicle costs per load [euro]	0.00	0.00	0.00	0.00	taken from Input basic
transport energy [MJ/ton.km]	4.48	4.48	4.48	4.48	taken from Input basic
total transport [ton.km]	54,403	211,847	392,036	1,535,414	transfer from LOCAgistics
transported weigt per trip (if volume limited) [ton]	32.0	60.0	32.0	60.0	max volume/specific volume

LOCAgistics chain design

Loading/unloading basic					
transport type being (un)loaded	truck	walking floor	truck	walking floor	taken from Input basic
loading costs [euro/m3]	0.63	0.31	0.63	0.31	taken from Input basic
unloading costs [euro/m3]	0.5	0.25	0.5	0.25	taken from Input basic
loading energy [MJ/m3]	3.13	3.00	3.13	3.00	taken from Input basic
unloading energy [MJ/m3]	3.13	3.00	3.13	3.00	taken from Input basic
Pretreatment					
name	pelletising	grinding	pelletising	grinding	
biomass output	pellets	powder	pellets	powder	
pretreatment costs [euro/m3]	22.80	9.74	22.80	9.74	
pretreatment energy [MJ/m3]	4.00	6.00	4.00	6.00	
drying costs [euro/ton moisture]	0.00	0.00	0.00	0.00	
drying energy [MJ/ton moisture]	0.00	0.00	0.00	0.00	
Percentage moisture content	14	9	15	10	

LOCAgistics calculation

Costs and revenues value chain					
	organge = fixed				
Costs	**B1 to IC1**	**B1(IC1) to PP**	**B2 to IC1**	**B2(IC1) to PP**	**Sum**
purchase costs [euro]	165,818	0	232,815	0	398,632
storage costs [euro]	9,535	23,470	68,300	168,124	269,428
transport costs [euro]	5,542	10,946	39,939	79,336	135,764
number of transports	115	61	825	440	1,441
loading/ unloading costs [euro]	10,410	3,175	74,569	22,741	110,895
pretreatment costs [euro]	210,036	55,216	1,504,584	395,537	2,165,373
drying costs [euro]	0	0	0	0	0
variable conversion costs [euro]	0	110,545	0	791,886	902,432
fixed conversion costs [euro]	0	0	0	625,000	625,000
total conversion costs [euro]					1,527,432
Revenues					
electricity [euro]	7,294,567	electricity * payment electricity			
heat [euro]	1,035,200	heat * payment heat			

Costs and revenues value chain	
Costs	
purchase costs [euro]	biomass shipped dry [ton dm] * biomass costs at roadside [euro/ton dm]
storage costs [euro]	biomass shipped dry [ton dm] * specific volume [m3/ton dm] * storage costs [euro/m3.month] * average storage time [month]
transport costs [euro]	(total transport [ton.km] * variable vehicle costs per driven km [euro/km])/ transported weigt per trip (if volume limited) [ton]
number of transports	biomass shipped dry [ton dm] / max volume or year consumed biomass / transported weight (in case of volume limited)
loading/ unloading costs [euro]	biomass shipped dry [ton dm] * specific volume [m3/ton dm] * (loading costs [euro/m3] + unloading costs [euro/m3])
pretreatment costs [euro]	biomass shipped dry [ton dm] * specific volume [m3/ton dm] * pretreatment costs [euro/m3]
drying costs [euro]	biomass shipped dry [ton dm] * specific volume [m3/ton dm] * drying costs [euro/ton moisture]
variable conversion costs [euro]	biomass shipped dry [ton dm] * variable costs conversion [euro/ton dm input]
fixed conversion costs [euro]	fixed costs plant + conversion [euro /year] ONLY ONCE!
total conversion costs [euro]	variable conversion costs + fixed conversion costs [euro]

LOCAgistics output

Output simple chain calculation

Case description	Burgundy
Calculation number	1
Biomass chain name	bioenergy

Total throughput:

[ton dm]:

from sources	30,081

Revenues and costs:

[euro]

electricity revenues	7,294,567		
heat revenues	1,035,200	total revenues	8,329,766
purchase costs	398,632		
storage costs	269,428		
transport costs	135,764		
loading/unloading costs	110,895		
pretreatment costs	2,165,373		
drying costs	0		
conversion costs	1,527,432	total costs	4,607,524
		profit	3,722,243

Demonstration

public site for s2biom tools:

http://s2biom-test.alterra.wur.nl

from main menu you can access:

- **Biomass chain data**
  - Supply viewer
  - Cost/supply viewer
- **Tools**
  - Matching tool (Bio2Match)
  - LocaGIStics

Thank you for your attention!

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Bert Annevelink, Bas Vanmeulebrouk, Berien Elbersen

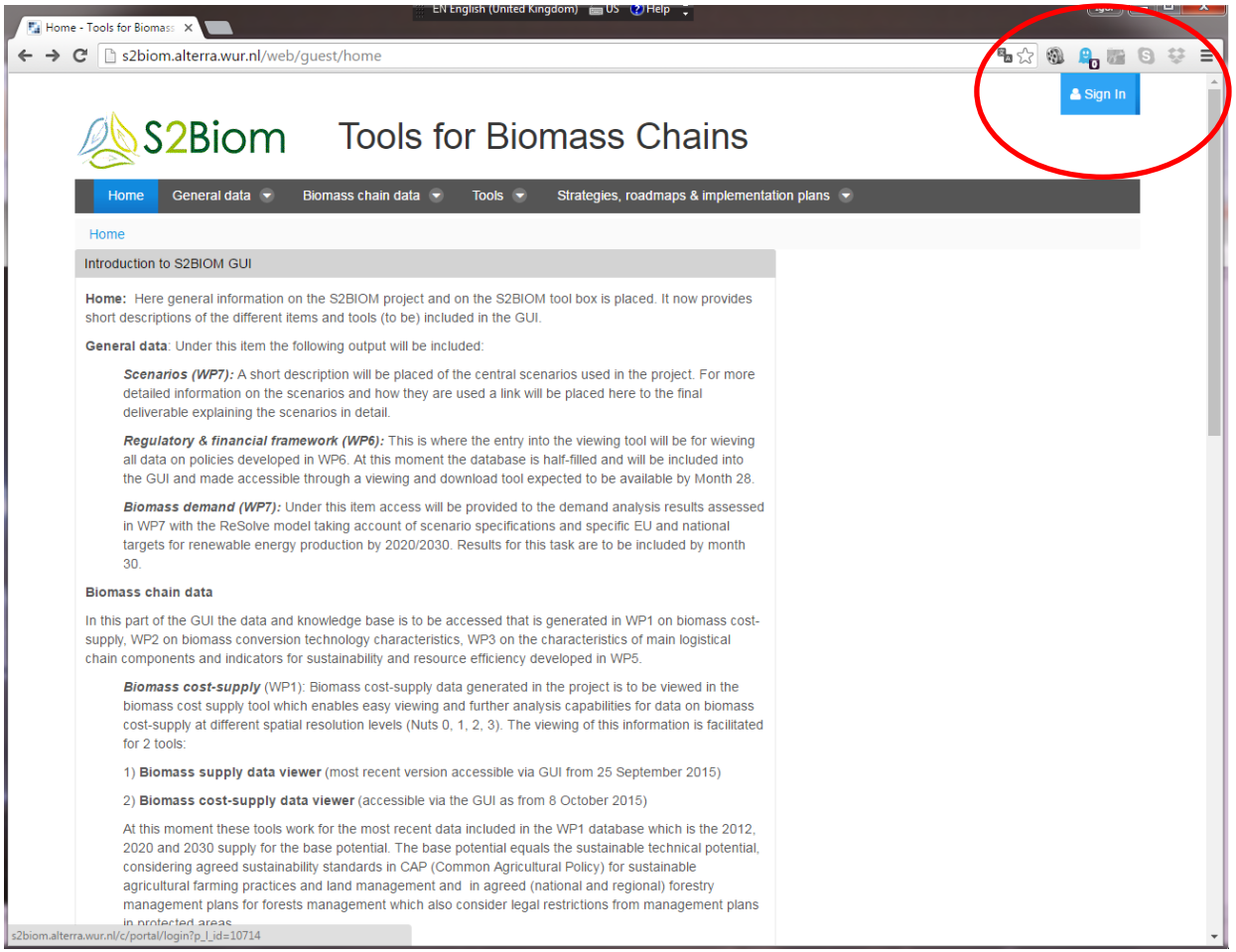



This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°608622.

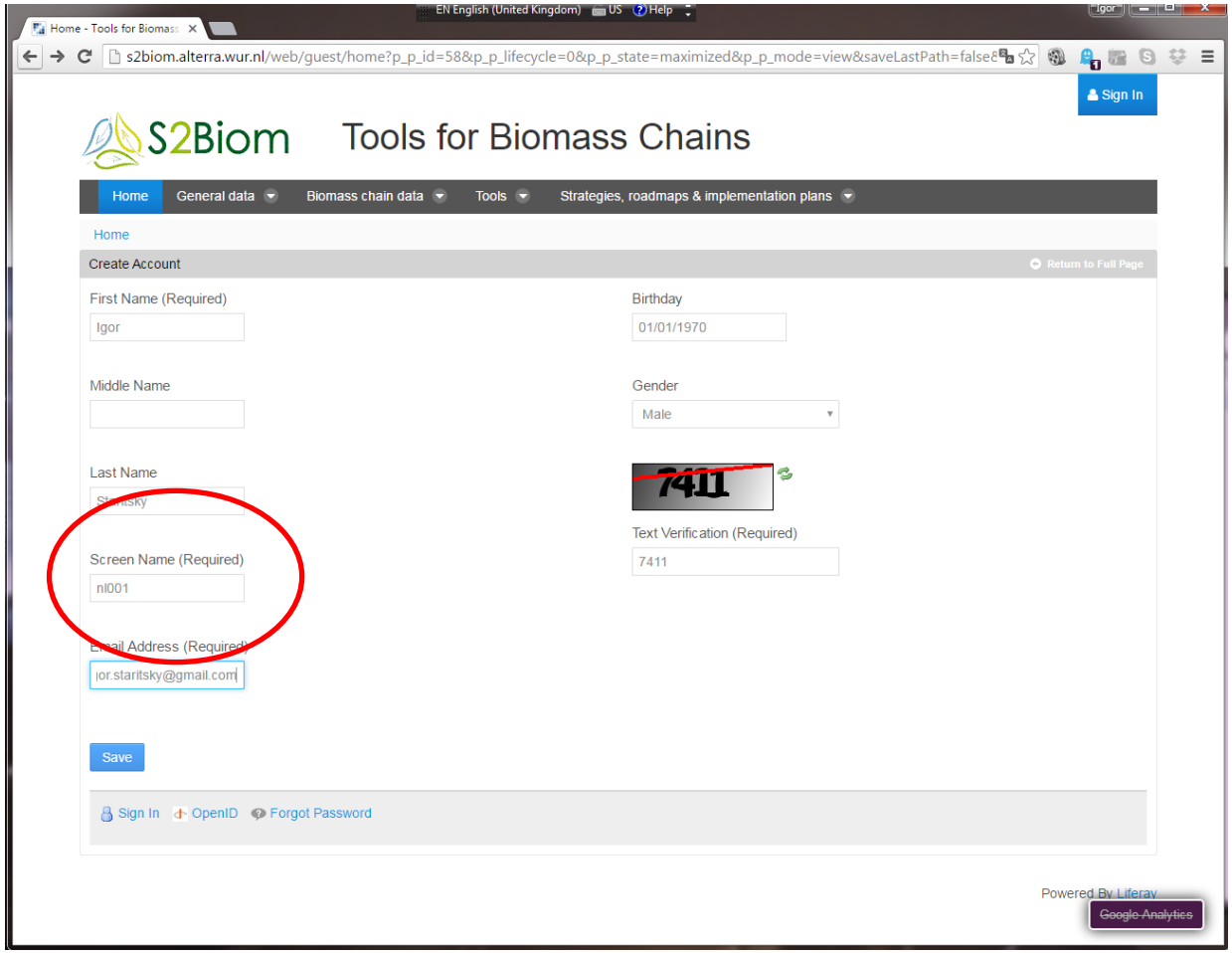
Now, go and find out for yourself

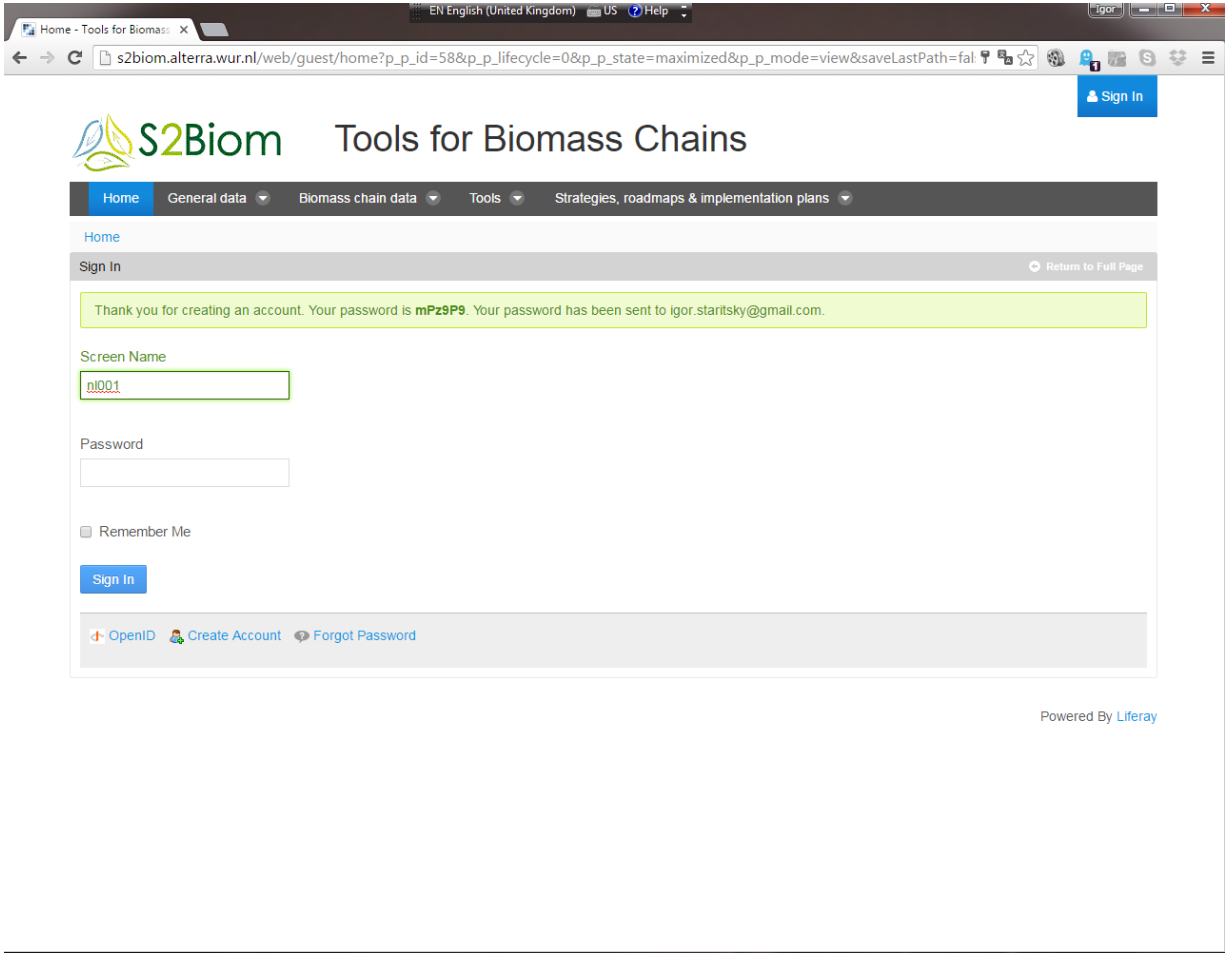
- **Make your own login code**
- **Goto: http://s2biom-test.alterra.wur.nl**
- **Push Sign In button, top right**
- **Use Create account for new account (follow instructions on screen)**
- **Suggested username:**
  - Find your student number on the list, say 25
  - Create username GR_0025

http://s2biom-test.alterra.wur.nl



Create new account

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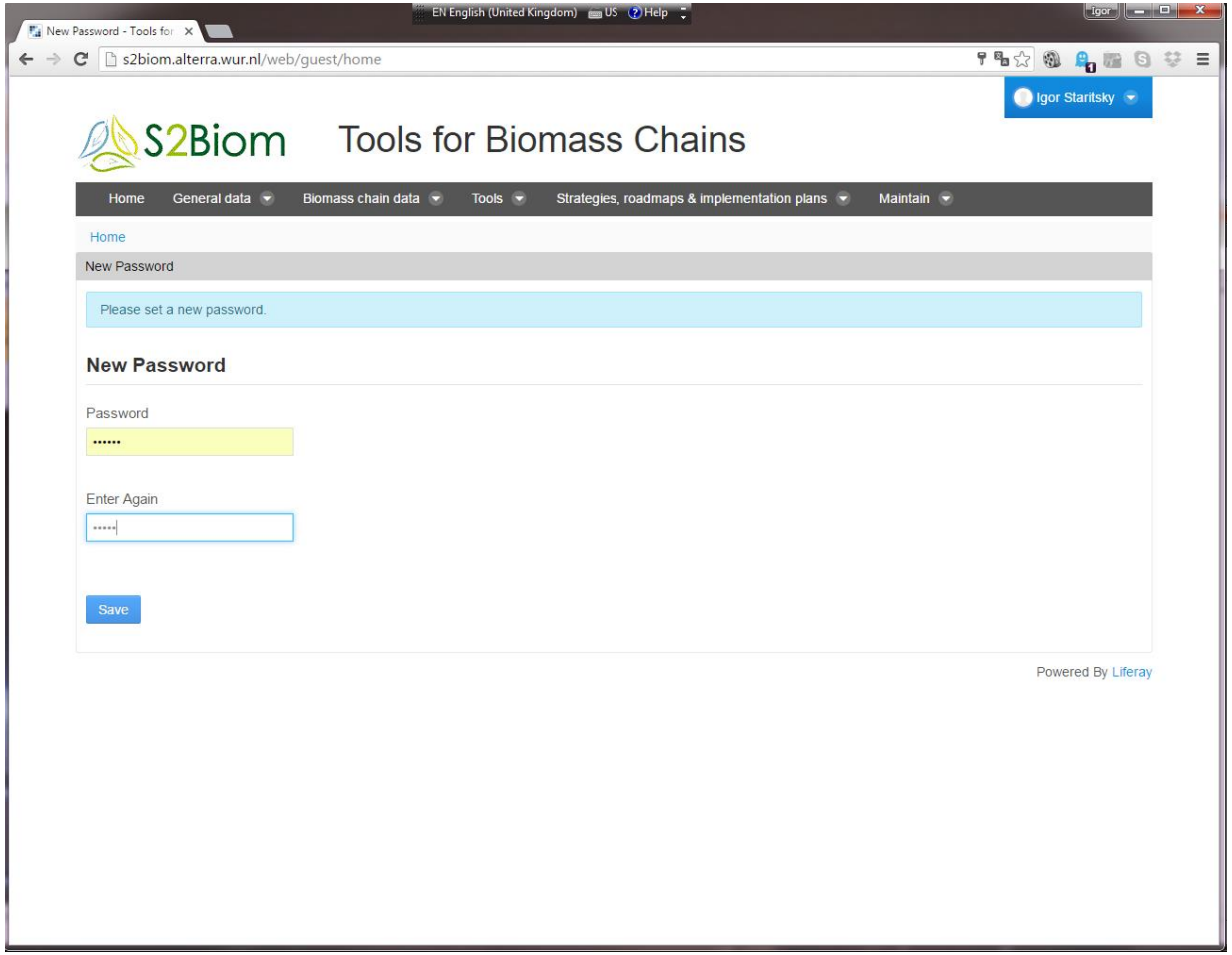
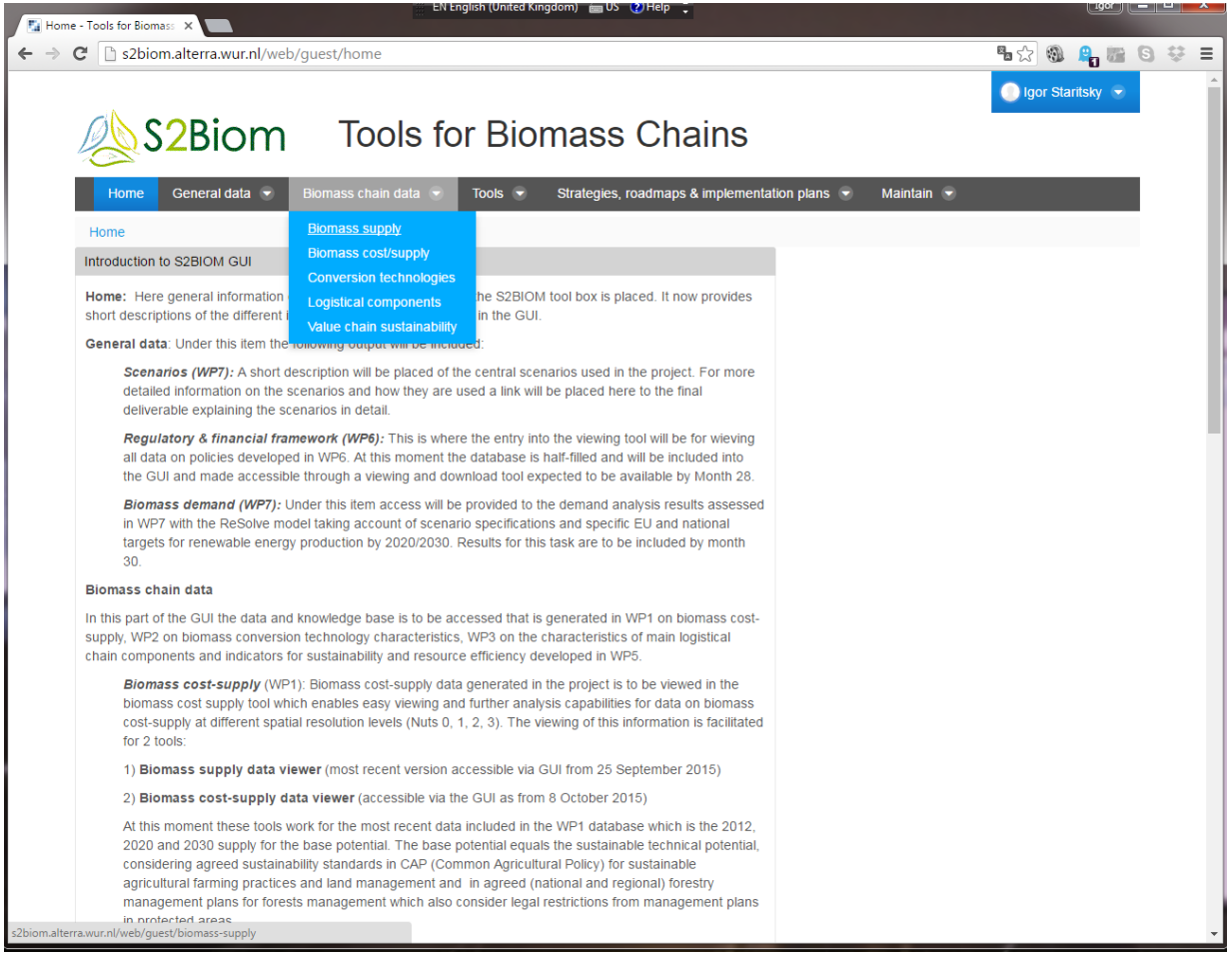
Create Account
Forgot Password
Powered By Liferay

Accept and make nice password

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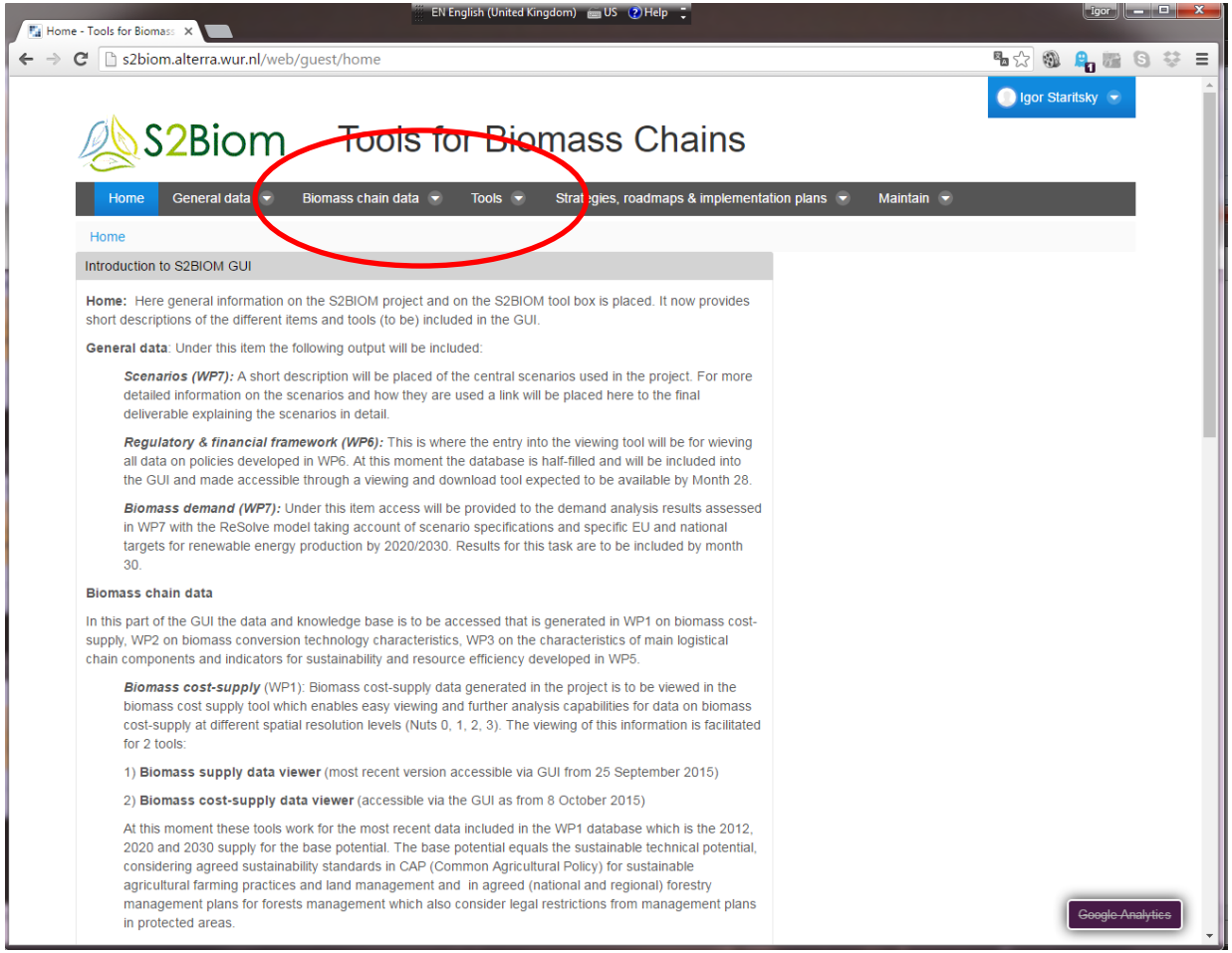
Biomass chain data
Tools
Strategies, roadmaps & implementation plans
Maintain
Biomass supply
Biomass cost/supply
Conversion technologies
Logistical components
Value chain sustainability
Home
Introduction to S2BIOM GUI
Home: Here general information
the S2BIOM tool box is placed. It now provides
short descriptions of the different
in the GUI.
General data: Under this item the
Scenarios (WP7): A short description will be placed of the central scenarios used in the project. For more detailed information on the scenarios and how they are used a link will be placed here to the final deliverable explaining the scenarios in detail.
Regulatory & financial framework (WP6): This is where the entry into the viewing tool will be for wieving all data on policies developed in WP6. At this moment the database is half-filled and will be included into the GUI and made accessible through a viewing and download tool expected to be available by Month 28.
Biomass demand (WP7): Under this item access will be provided to the demand analysis results assessed in WP7 with the ReSolve model taking account of scenario specifications and specific EU and national targets for renewable energy production by 2020/2030. Results for this task are to be included by month 30.
Biomass chain data
In this part of the GUI the data and knowledge base is to be accessed that is generated in WP1 on biomass cost-supply, WP2 on biomass conversion technology characteristics, WP3 on the characteristics of main logistical chain components and indicators for sustainability and resource efficiency developed in WP5.
Biomass cost-supply (WP1): Biomass cost-supply data generated in the project is to be viewed in the biomass cost supply tool which enables easy viewing and further analysis capabilities for data on biomass cost-supply at different spatial resolution levels (Nuts 0, 1, 2, 3). The viewing of this information is facilitated for 2 tools:
1) Biomass supply data viewer (most recent version accessible via GUI from 25 September 2015)
2) Biomass cost-supply data viewer (accessible via the GUI as from 8 October 2015)
At this moment these tools work for the most recent data included in the WP1 database which is the 2012, 2020 and 2030 supply for the base potential. The base potential equals the sustainable technical potential, considering agreed sustainability standards in CAP (Common Agricultural Policy) for sustainable agricultural farming practices and land management and in agreed (national and regional) forestry management plans for forests management which also consider legal restrictions from management plans
s2biom.alterra.wur.nl/web/guest/biomass-supply

Main screen


Home - Tools for Biomass
s2biom.alterra.wurl.nl/web/guest/home
Igor Staritsky
S2Biom
Tools for Biomass Chains
Home
General data
Biomass chain data
Tools
Strategies, roadmaps & implementation plans
Maintain
Home
Introduction to S2BIOM GUI
Home: Here general information on the S2BIOM project and on the S2BIOM tool box is placed. It now provides short descriptions of the different items and tools (to be) included in the GUI.
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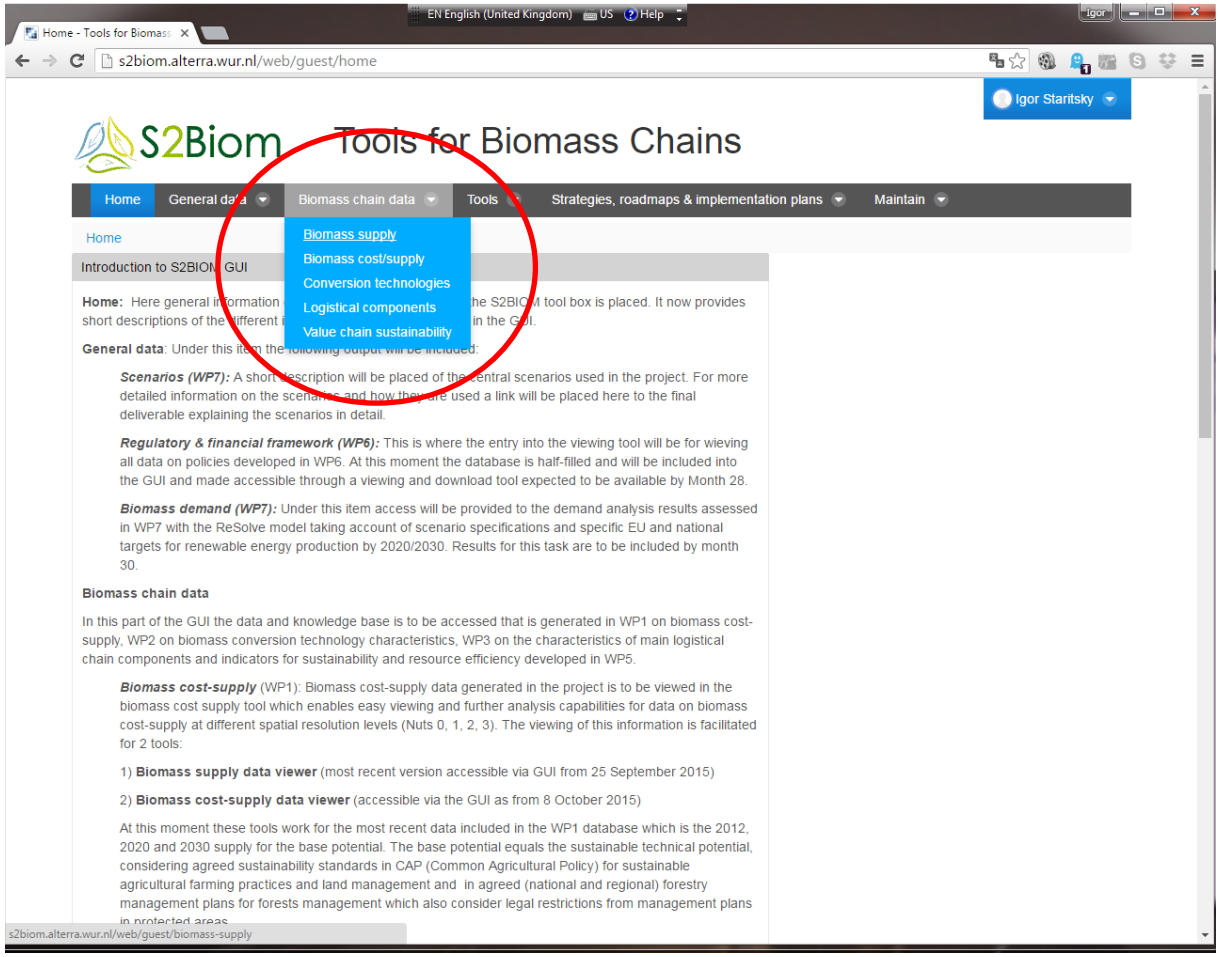
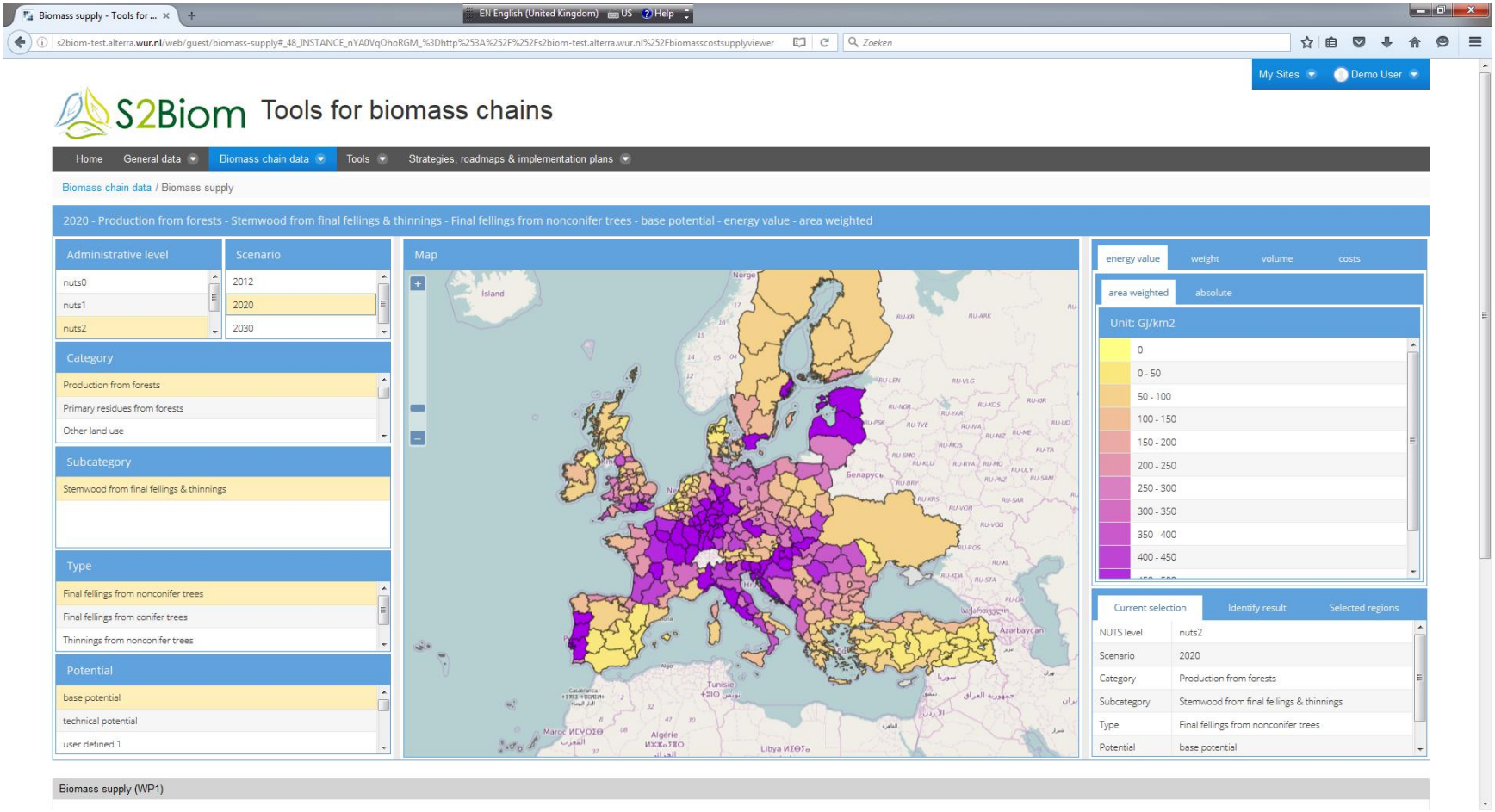
Biomass demand (WP7): Under this item access will be provided to the demand analysis results assessed in WP7 with the ReSolve model taking account of scenario specifications and specific EU and national targets for renewable energy production by 2020/2030. Results for this task are to be included by month 30.
Biomass chain data
In this part of the GUI the data and knowledge base is to be accessed that is generated in WP1 on biomass cost-supply, WP2 on biomass conversion technology characteristics, WP3 on the characteristics of main logistical chain components and indicators for sustainability and resource efficiency developed in WP5.
Biomass cost-supply (WP1): Biomass cost-supply data generated in the project is to be viewed in the biomass cost supply tool which enables easy viewing and further analysis capabilities for data on biomass cost-supply at different spatial resolution levels (Nuts 0, 1, 2, 3). The viewing of this information is facilitated for 2 tools:
1) Biomass supply data viewer (most recent version accessible via GUI from 25 September 2015)
2) Biomass cost-supply data viewer (accessible via the GUI as from 8 October 2015)
At this moment these tools work for the most recent data included in the WP1 database which is the 2012, 2020 and 2030 supply for the base potential. The base potential equals the sustainable technical potential, considering agreed sustainability standards in CAP (Common Agricultural Policy) for sustainable agricultural farming practices and land management and in agreed (national and regional) forestry management plans for forests management which also consider legal restrictions from management plans in protected areas.
Google Analytics

Accessing the tools



Biomass Supply viewer



Biomass cost/supply