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WORK PLACEMENT

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TABLE OF CONTENT

ACKNOWLEDGEMENTS....3

TABLE OF CONTENT....5

INTERNSHIP PRESENTATION....7

ABSTRACT....9

INTRODUCTION....11

I/ PRESENTATION OF THE COMPANY....13

1-AGH University of science and technology....13

2-EDF Polska....15

II/ WORK COMPLETED....17

1-Background....17

2-Working tools....19

3-Results....28

4-Optimisation....36

III/ ASSETS AND PERSONAL IMPRESSIONS....39

CONCLUSION....41

APPENDICES....43

REFERENCES TABLE....49

INTERNSHIP PRESENTATION

1-Subject and objectives.

The topic of our internship is to optimize the use of biomass in Poland.

For this, we must develop a model using the General Algebraic Modeling System (GAMS) software which allows to calculate the CO2 emissions, energy embedded and cost. This model must take into account several parameters: planting, harvesting, transport, conversion of biomass…

We must find a compromise which allows to have low CO2 emissions and energy embedded, while having a low cost. The goal: optimize the use of biomass in Poland.

To realize this model on GAMS, we must search on the internet to find the energy embedded and CO2 emissions for each stage (planting, fertilizer, transport…).
When this values are found, we will put them in Excel sheets which will be used in the software GAMS.

2-Schedule

Our schedule was always the same. The work began at 9 am and finished at 4 pm. We had an hour break for lunch. On Friday, it was possible to leave work earlier, around 3:30 pm. Our days off were Saturday and Sunday.

During the first six weeks, we have developed the model in the GAMS software and searched a lot of data on the internet. After this, we tried to improve the model in adding more parameters and giving a more pleasant form to the model.

ABSTRACT

In order to respect the Kyoto protocol, Poland has decided to become interested in renewable energy. Indeed, the protocol aims to fight against climate change by reducing carbon dioxide emission

To preserve the Earth and limit losses (energy embedded, CO2 emission…), EDF Polska is interested in a study to use biomass as bio electricity. It could permit, after the development of a model with GAMS software, to analyze energy and CO2 emissions embedded in biomass delivery to EDF Polska plants.

Our work was in this perspective. Indeed, the scientific objective of the work is to develop this model that will support decision-making process of EDF Polska, by showing the optimal supply chain of biomass in sense of minimization of total energy embedded in its processing and transportation.

The goal of the model is to calculate energy embedded and GHG emissions for biomass delivery to EDF Polska Plants.

First of all, we had to become familiar with GAMS, then, look for the data that we needed, as the energy and CO2 embedded for planting or for the transport of this biomass, for example.

When it was done, we had to think about how to improve the model to become it as accurate as possible and realize what factor consumes more energy and emits more CO2 in order to minimize the impact of biomass on the environment.

KEY WORDS

- Kyoto Protocol
- GAMS software
- Biomass
- Energy embedded
- CO2 embedded

-

INTRODUCTION

Poland is one of the 30 most polluting countries in the world. Indeed, there are the most polluting plants in this country such Elektrownia Bełchatów which is a coal plant that has emitted over 30 Mt CO2 in 2008. Thus, to overcome this problem, Poland has decided to start manufacturing of biomass to generate bio electricity that can displace electricity created by coal.

Biomass is organic non-fossil material of biological origin - including forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, fast-growing trees and plants, and municipal and industrial wastes. This biomass is used to produce bio-electricity. Indeed, one of the most important rules of development of EDF is sustainability it becomes necessary to take this aspect into account in making decisions about logistics and technological choices to minimize negative environmental impacts.

In order to improve the production of the bio electricity, some researchers work on this and try to reduce the cost and the impact on the environment of this biomass.

KEY WORDS

- Polluting
- Coal plant
- Bio electricity
- Biomass
- Impact on the environment
- cost

I/ PRESENTATION OF THE COMPANY

1-AGH University of science and technology

The desire to create the Academy of Mining in Krakow was born in 1912 by a group of mining engineers and activists. The Academy had to wait until the end of the First World War to begin its activities. It was inaugurated on the 20th of October 1919 by the Head of State, Józef Piłsudski.

During the Second World War, the building was occupied by the Nazis. After the war, a group of professors, staff members and students reclaimed the ruined main building of the Academy and more than 500 students began their courses.

In 1969, the university was named the Stanisław Staszic University of Mining and Metallurgy.

Figure 1: AGH university **[1]**

Today, AGH University of Science and Technology is the second largest technical university in Poland, located in Krakow. It is composed of 15 faculties and two inter-faculty schools:

- Faculty of Mining and Geo-engineering
- Faculty of Engineering and Industrial Computer Science
- Faculty of Electrical Engineering, Automatics, Computer Science and Electronics
- Faculty of Mechanical Engineering and Robotics
- Faculty of Geology, Geophysics and Environmental Protection
- Faculty of Mining Surveying and Environmental Engineering
- Faculty of Materials Science and Ceramics
- Faculty of Foundry Engineering
- Faculty of Non-Ferrous Metals
- Faculty of Drilling, Oil and Gas
- Faculty of Management
- Faculty of Fuels and Energy
- Faculty of Physics and Applied Computer Science
- Faculty of Applied Mathematics
- Faculty of Humanities
- Inter-Faculty School of Power Engineering
- Inter-Faculty School of Biomedical Engineering

Currently, in the university, there are over 34,000 students who can gain qualifications in 30 branches of studies and over 170 specializations. AGH University serves the science, economy and society through educating students and the development of the scientific and research staff, as well as conducting scientific research.

The faculty of Fuels and Energy, where we work, is one of the youngest faculties at the University of Science and Technology. It was created to meet the growing

demand for fuels and energy of the highest quality and the requirements of sustainable development based on effective implementation of clean energy and green renewable energy. **[2]**

2-EDF Polska

EDF (Electricité de France) is a major player in the production of electricity and heat all around the world. This group was installed in Poland since 1993. It became one of the largest groups of the country, and today, it tries to combine energy production and environmental protection.

The activities of EDF Group in Poland are co-ordinated by the EDF Polska, a ten-person team seated in Warsaw, which is responsible for representing the EDF Group in Poland. Its task is also to guide and co-ordinate activities of service and production companies belonging to the EDF Group in Poland. It president is Philippe Castanet.

Figure 2: EDF plants in Poland **[3]**

EDF Group in Poland consists of one trading company whose key areas of its activity are energy trade on wholesale market as well as supply of energy to end consumers and also several plants generating heat.

As a world-wide energy group, EDF plays a significant part in economic and social development and is responsible to future generations for environment protection. All Polish EDF companies act upon the rules of sustainable development. An outstanding example of this engagement is the project of "Coal Recovery Plant from waste coal piles". We have to notice that all the companies have obtained 14001 certificates. **[3]**

II/ WORK COMPLETED

1-Background

Many chemicals pollute the atmosphere, but the main element is the CO2.

The use of biomass in EDF Polska plants has great importance to make it possible to fulfill its strategy to meet renewable energy sources quotas in forthcoming years. Experiments of co-firing have already been made in different plants as ERSA (Elektrownia Rybnik S.A.) and Kogeneracja and are being spread to ECK and ECW with a target of 500 kt/year of dry biomass in 2010. EDF Polska plans as well to invest in co-injection in Kogeneracja and ECK, followed by ERSA, in order to achieve a new goal of 2 Mt/year of biomass in 2020.

In order to ensure the supply of biomass and to meet the target of 60% of non-wooden products in the biomass mix required by the Polish Administration, investigations have been carried out concerning agriculture by-products, energy crops and recycled products in order to make it available at a competitive price while mitigating the risks connected to the development costs. Quite often overlooked is the energy embedded ("inserted") in the cultivation of biomass, its processing and transportation to the place where its chemical energy is converted to heat and/or electricity. As one of the most important rules of development of EDF is sustainability it becomes necessary to take this aspect into account in making decisions about logistics and technological choices to minimize negative environmental impacts. But, this production has also an impact on the environment, and the mission of researchers is to know how improve the production to minimize this impact and the cost of the biomass.

Indeed, there are different processes to product Biomass. We also consider that the system consisting of the following components:

- The first process is in the fields, where biomass is grown and harvested
- The second is the storages, where biomass is stored and eventually processed for example, dried, pelletized…

- The third is the sidetracks, where biomass is loaded on train cars and
- And the last process is destination points.

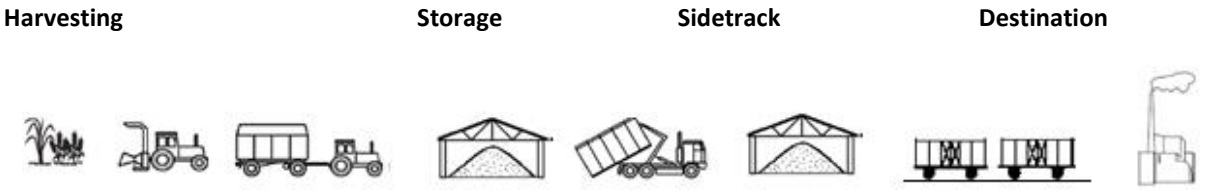


Figure 3: Different processes for the use of biomass

In all this process, we have to take into account to different parameters which are very polluting. In the first process, this is the diesel needed to the machine which is a problem for the environment because, to harvest, the consumption of fuel is very important.

In the second process, the energy for drying and pelletizing is significant and consequently, the emission of CO2 is significant too. Moreover, storing biomass too long may be a waste of money. Biomass is bulky, so the storage should not take long to make room for other biomass just harvesting.

The transport is a major emitter of CO2 because the fields are located relatively far from the places for storage and from the power plant. Thus, the journey is sometimes long.

First of all, we study only two types of the biomass: the willow and the maize (which is the corn and the stover), and only three forms of the biomass: the raw, the chips and the pellets.

It was assumed, for our work, that willow and maize is chipped on fields and then transported to the storage areas located nearby, where it can be further processed i.e. dried and pelletized. Then, biomass in the form of chips or pellets is transported by heavy duty vehicles (trucks) to the sidetracks where it is loaded into the train cars and delivered to the destination sites. **[4]**

2-Working tools

The aim of our work, during this internship, is to optimize the use of biomass in Poland. With the software GAMS, we will create a model that will allow us to calculate the energy embedded and CO2 emissions throughout the process. Then, we will try to optimize the use of biomass by reducing energy losses and emissions of CO2.

The GAMS Software

The goal of our work was to optimize the production of biomass.

Our main work tool was GAMS Software. This software, the General Algebraic Modeling System (GAMS) is a high-level modeling system for mathematical programming and optimization. It allows to build large maintainable models that be adapted quickly to new situations. GAMS is specifically designed for modeling linear, non-linear and mixed integer optimization problems. The system is especially useful with large, complex problems. **[5]**

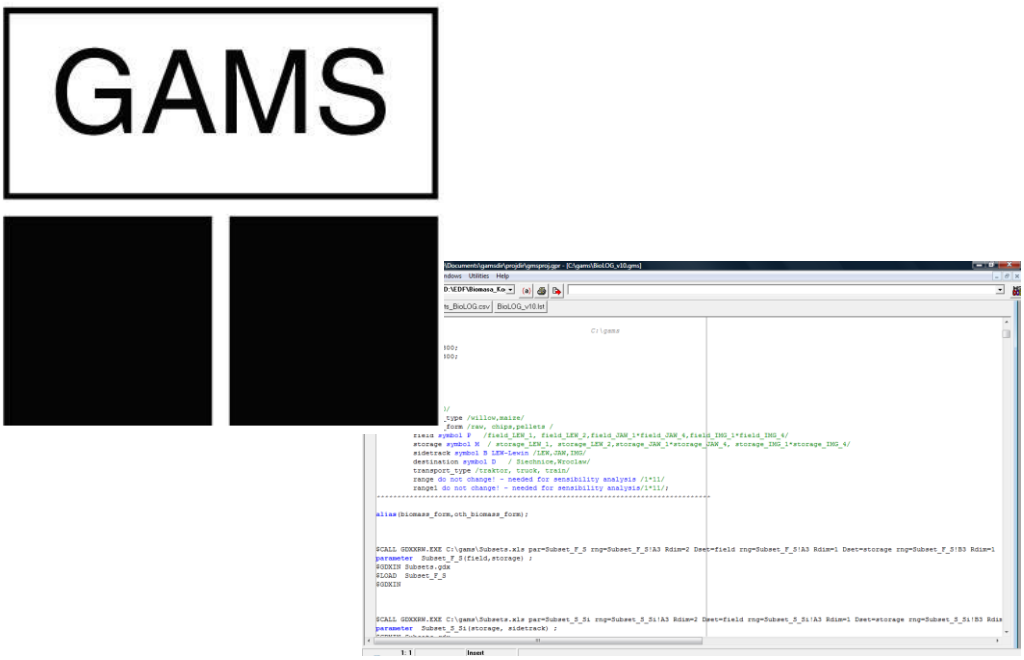


Figure 4: GAMS software **[5]**

The basic components of the structure of a GAMS model are **[5]**:

INPUT	OUTPUT
- Sets - Data - Variables - Equations - Model and Solve statements - Display statements	- Echo Print - Reference Maps - Equation Listings - Status Reports - Results

Sets are the basic building blocks of a GAMS model, corresponding exactly to the indices in the algebraic representations of models.

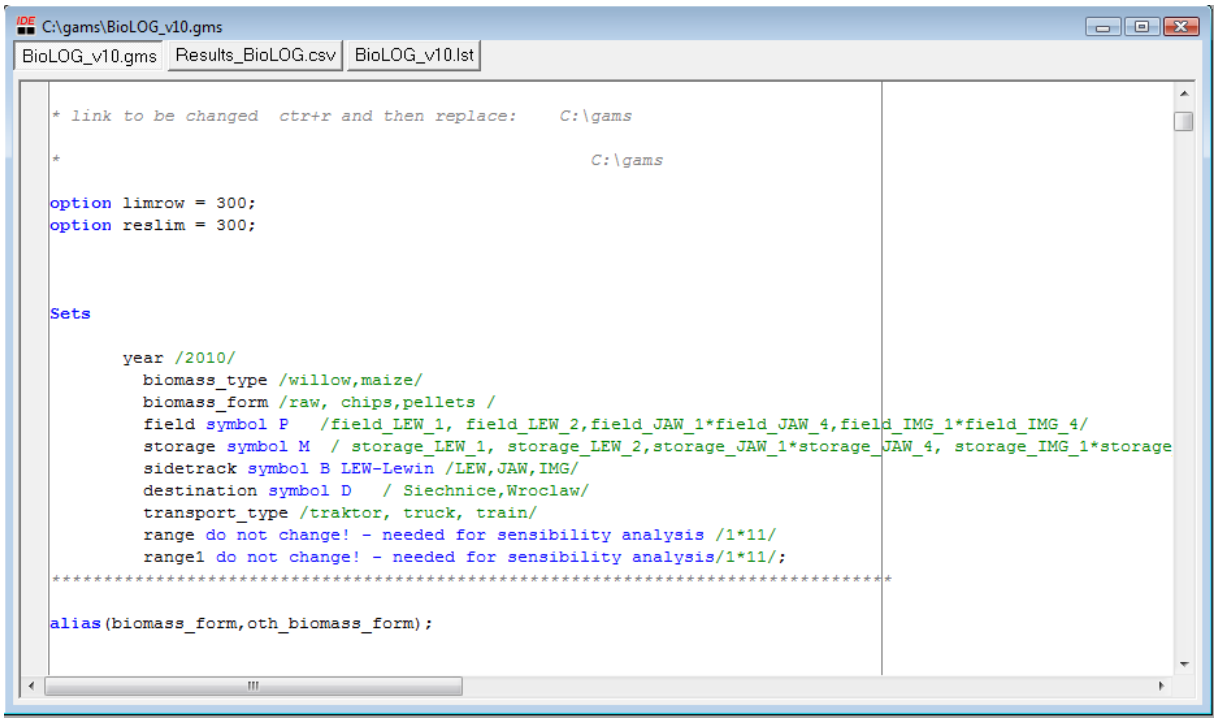


Figure 5: the sets of our GAMS model

In our model, we had 7 most important sets: biomass_type which is the different type of biomass (we have to specify in the softare, the name of this biomass, here: willow and maize), biomass_form, which is different form of biomass, like raw, chips (raw cut) and pellets (chips with densification). After, we have to give the different place where biomass is treated: field, storage, sidetrack, destination (it is the power plants). Then, we have to give the different transport type, like tractor, truck and train.

To run the model, we have to define some parameters, which are the “conditions” of the model. We can write this parameters as a list, a table or import the parameters from an excel file. This is what we have done.

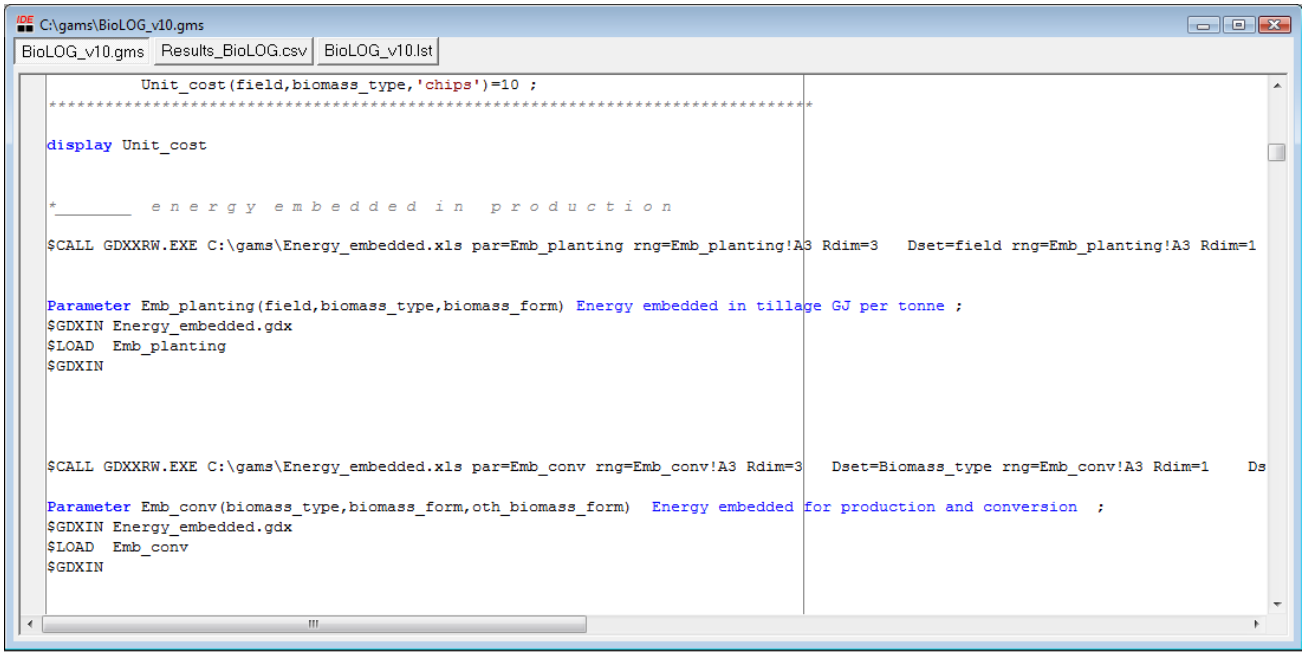


Figure 6: parameters imported from Excel file

The different parameters are:

- The distance between each place: field to storage, storage to sidetrack and sidetrack to destination place.
- The demand for biomass in destination place and the cost of the biomass.
- The energy embedded in production, for planting, conversion and drying of biomass and the energy embedded in transport, for tractor, truck and train.

- The CO2 embedded in production, for planting, conversion and drying of biomass and the energy embedded in transport, for tractor, truck and train.

To import the data from an excel file to GAMS, first of all, we had to do a table in Excel. We had to give to the table a proper form in order to GAMS can read it as a parameter.

	A	B	C	D
1	ded kgCO2 per ton and km			
2	biomass_type	biomass_form	transport_type	CO2_embedded_tr
3	maize	raw	traktor	0,03
4	maize	raw	truck	0
5	maize	raw	train	0
6	maize	chips	traktor	0,03
7	maize	chips	truck	0,09
8	maize	chips	train	0,023
9	maize	pellets	traktor	0
10	maize	pellets	truck	0,09
11	maize	pellets	train	0,023
12	willow	raw	traktor	0,03
13	willow	raw	truck	0
14	willow	raw	train	0
15	willow	chips	traktor	0,03
16	willow	chips	truck	0,09
17	willow	chips	train	0,023
18	willow	pellets	traktor	0
19	willow	pellets	truck	0,09
20	willow	pellets	train	0,023

Figure 7: table of parameter (CO2 embedded in transport) in Excel

In the first column, there are the sets, and in the last column, the data that correspond to the sets: this is the parameters.

Then we had to use a code to import this table in GAMS. This code is (this is an example for the parameter CO2 embedded in transport):

```
$CALL GDXXRW.EXE C:\gams\CO2_embedded.xls

par=CO2_transp rng=CO2_transp!A3 Rdim=3

Dset=biomass_type rng=CO2_transp!A3 Rdim=1

Dset=biomass_form rng=CO2_transp!B3 Rdim=1

Dset=transport_type rng=CO2_transp!C3 Rdim=1

Parameter CO2_transp(biomass_type,biomass_form,transport_type)

$GDXIN CO2_embedded.gdx

$LOAD  CO2_transp

$GDXIN
```

$CALL GDXXRW.EXE C:\gams\CO2_embedded.xls: With this, we call the Excel file called CO2_embedded which is saved in the folder gams, which is in the Disk C.

Par=CO2_transp rng=CO2_transp!A3 Rdim=3: with this line, we define the parameter. We call this parameter: CO2_transp. The rng (range) specifies in which Excel sheet, the table must be taken. A3 is the box where begins the table. And the Rdim determines how many sets there are.

Dset=biomass_type rng=CO2_transp!A3 Rdim=1

Dset=biomass_form rng=CO2_transp!B3 Rdim=1

Dset=transport_type rng=CO2_transp!C3 Rdim=1: With this, we just write the different sets, in which sheet they are, in where box begin the columns and the dimension (1 for one set)

$GDXIN CO2_embedded.gdx

$LOAD CO2_transp

$GDXIN: with this, we load the Excel file and GAMS can read the data in the table. The Excel file is imported.

If we don't use an excel file, the parameters can be write in list or table. Our first model GAMS had not the code to import the Excel file, so, the parameters were like in the figure 8.

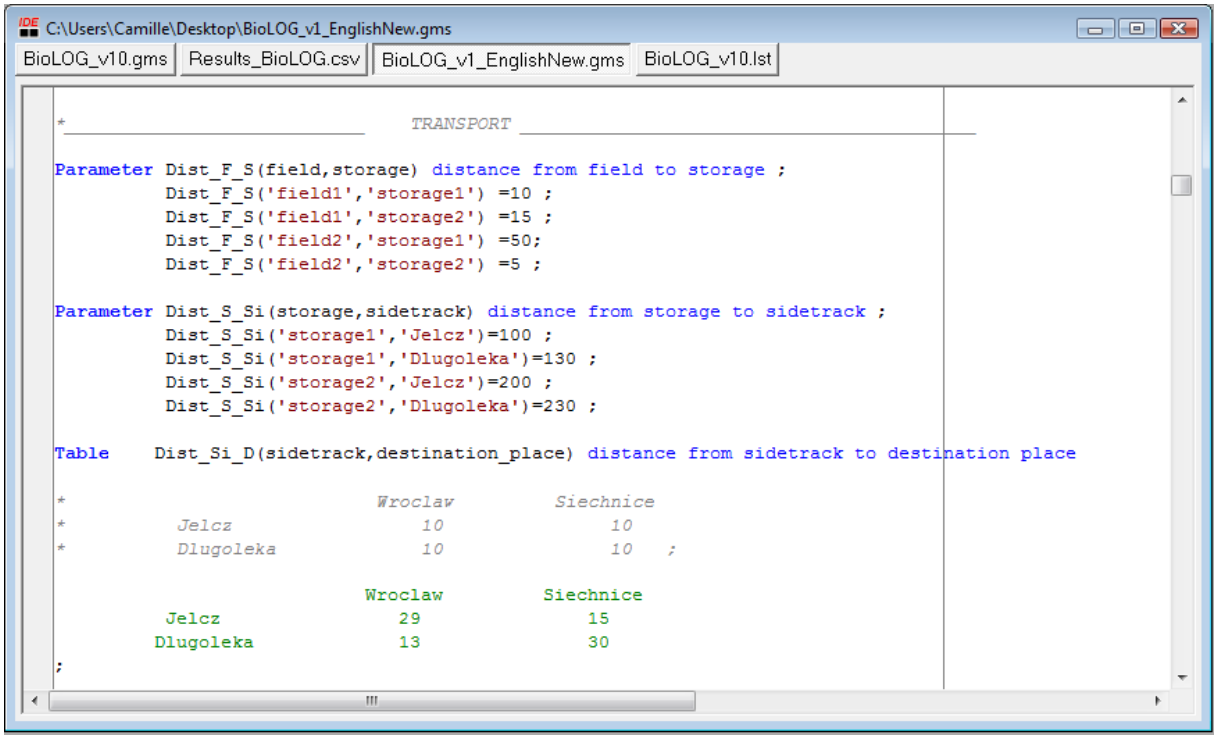


Figure 8: Parameters listed in GAMS

The variable statement of GAMS-expressed model only serve to declare the variables used in the rest of the program. Each variable is given a name, a domain if appropriate, and (optionally) text. Our model contains the following example of a variable statement:

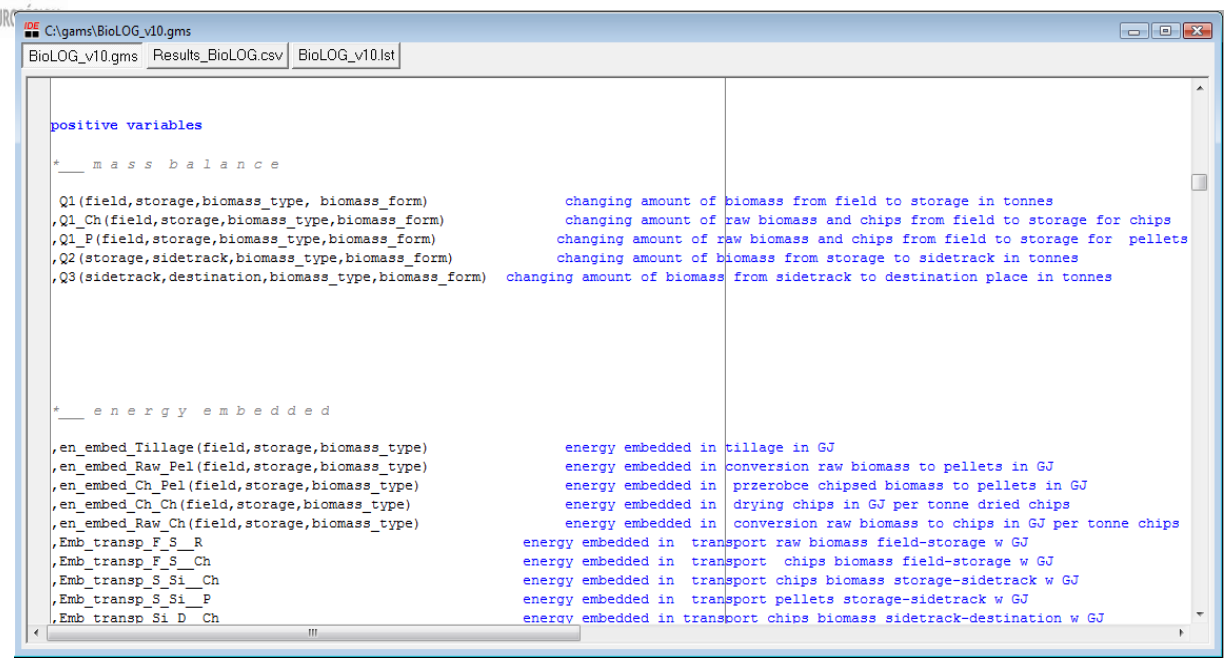


Figure 9: the positive variables

The main variables were defined as follows:

$Q_Ch_{F,S,t,bf}$ -Biomass dedicated for chips. The amount of biomass cuttings and chips entering to the storage and processed up there (chipped or dried), [Mg]

$Q_Pe_{F,M,t,,bf}$ - Biomass dedicated for pellets. The amount of biomass raw and chips entering to the storage, and up there pelletized, [Mg]

$Q2_{M,B,t,bf}$ - The amount of biomass chips and pellets directed from storage to sidetrack [Mg]

$Q3_{B,D,t,bf}$ - The amount of biomass chips and pellets directed from sidetrack to destination place, [Mg]

Finally, the most important and most complicated part of GAMS model is where there are the equations. They encompass both equality and inequality relationships, and they are used both to declare and define these relationships. These equations can be used to defined values or limits for the variables declared in the previous variable statements. In figure 10, there is an example of an equation that we used in our model for energy embedded in tillage.

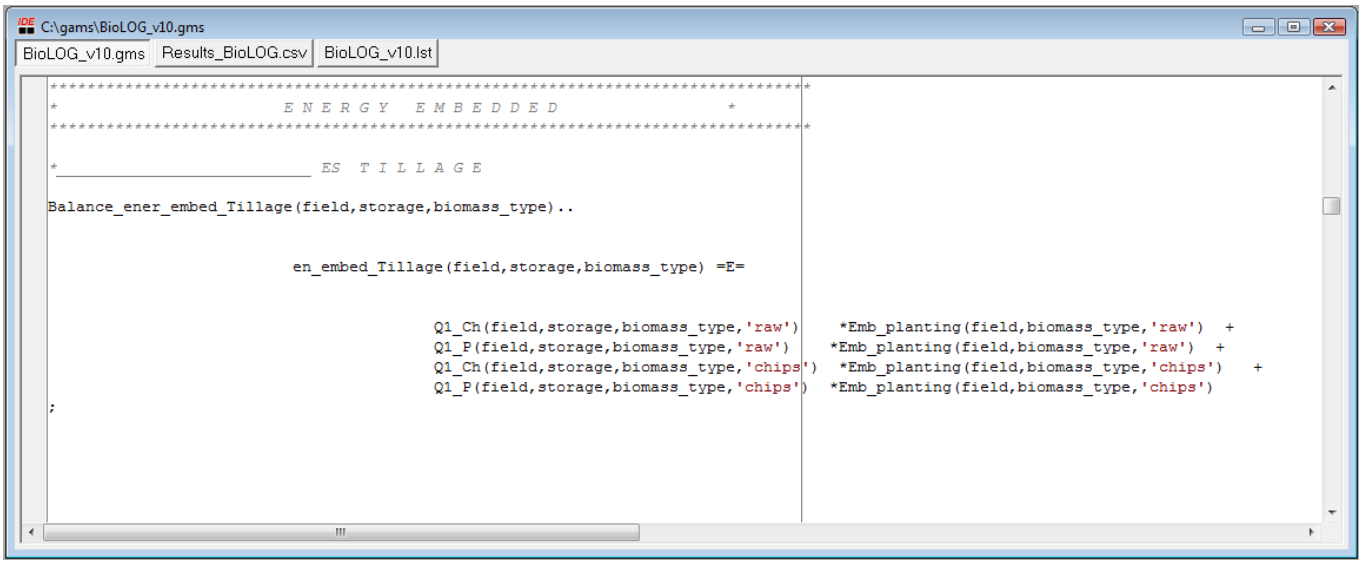


Figure 10: equation of our GAMS model

In this equation (fig 10) we can observe that the energy embedded in tillage, is the sum of the amount of each biomass type in each field multiply by the energy embedded to plant this biomass.

We have to be very careful to write equation because we must take the correct spelling of parameter, variable etc and do not forget some balance which could give a bad result.

The model statements precise which equations should be taken into account during the resolution. We do not need to ignore any equation, so we can plainly use the statement:

model model_name /all/;

GAMS has no explicit entity called the “objective function”. To specify the function to be optimized, you must create a variable and a solve statement. The solve statement precise which model to solve, the variable which should be optimized, if it should be maximized or minimized, and the solution procedure (linear lp or non linear for example nlp)

Solve Biomasa using LP minimizing h; where h is ‘all cost” in our model.

Research data

To use the model created with the software GAMS, we had to find data on the Internet and scientific journals. Indeed, in order to calculate the energy embedded and CO2 emissions for a precise path of biomass, we needed to know it for each step of the process.

We have narrowed our search to two types of biomass: the maize and willow. We had to find the energy and CO2 embedded for planting, harvesting, drying, and transport but also for the transformation of biomass into pellets or chips. Once again, we have narrowed our search to three transformations: raw to chips, raw to pellets and chips to pellets.

Process	Cumulative energy [GJ / ton of biomass] (GJ / km / ton-transport)	Cumulative CO_2 emissions [$kgCO_2$ / ton of biomass] ($kgCO_2$ / km / ton-transport)
Growing willow	0,81	33,95
chipping	0,137	9,175
drying	3,5	52,35
Pellets from biomass raw	3,52	16
Pellets with wood chips	2,37	110,4
transport	0,0016	0,05195

Table: The energy of a cumulative process for willow

Process	Cumulative energy [GJ / ton of biomass] (GJ / km / ton-transport)	Cumulative CO_2 emissions [kg CO_2 / ton of biomass] (kg CO_2 / km / ton-transport)
Growing maize	1,819	42,4
chipping	0,137	9,175
drying	3,5	2,35
Pellets from biomass raw	2,39	41
Pellets with chips	2,29	30
transport	0,0016	0,05195

Table: The energy of a cumulative process for maize.

This work lasted one month during which we have carefully read many scientific journals such as you find in Appendix 1. Indeed, we do not just find a single good value; we must be able to verify this value with other journals made by other authors. If it is the same values, we can take it into account in our model. When we found intervals of data, we have created excel tables with low values, high values and medium values. Thus, we could see different scenarios when we ran the model on GAMS.

It is a work that requires patience, concentration and a good analytical mind.

3-Results

Once the model done, we can run it, and display the results. These results are listed, which is not very clear to read.

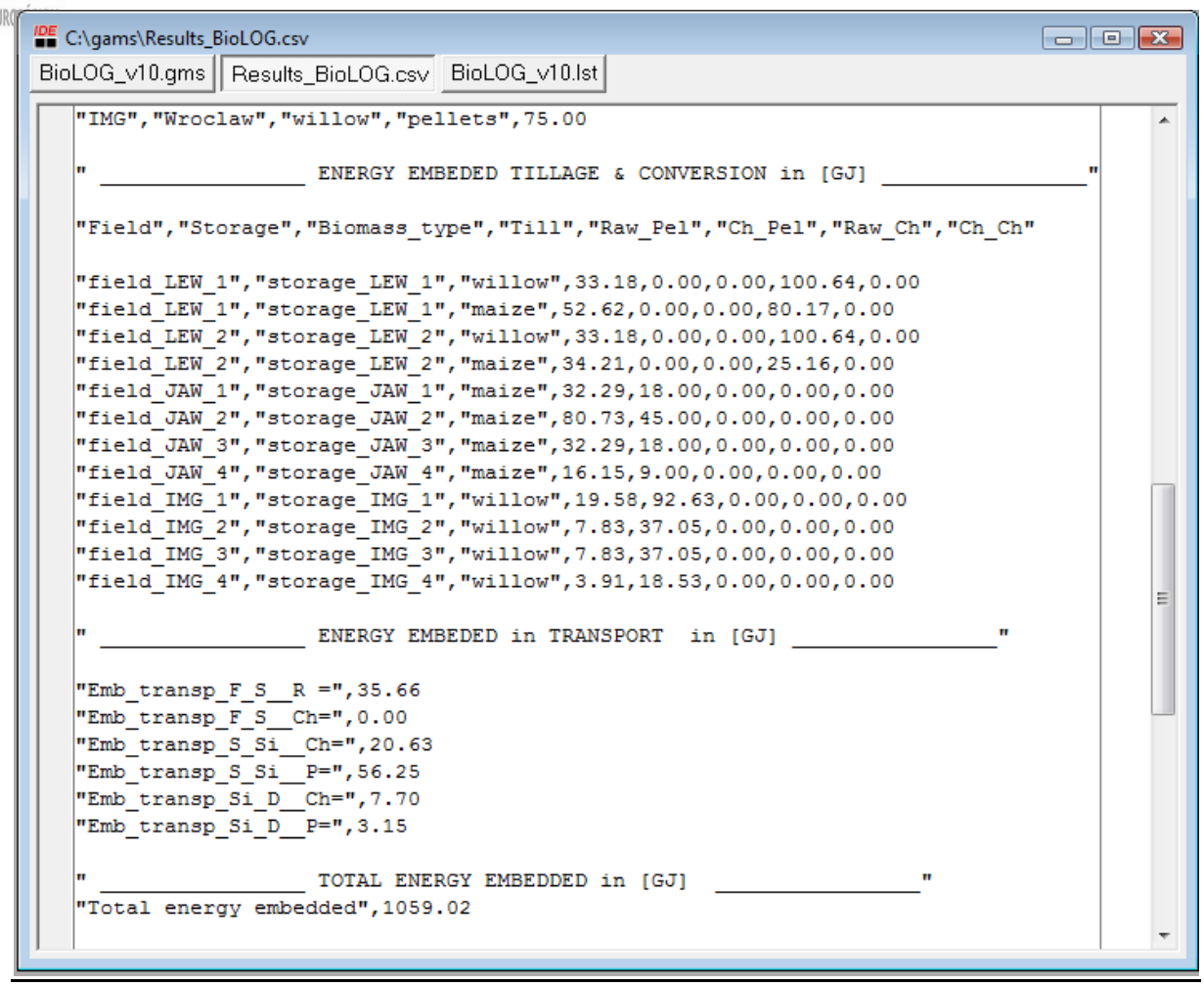


Figure 11: the results listed in GAMS

GAMS calculates the energy and the CO2 embedded in the production of biomass and also the price of this production.

Results can be presented for each process included in the model. Below an exemplary sheet with results is presented.

Results BioLOG

Version I. Copyright:ENVIRO, contact:awyrwa@agh.edu.pl

_____ Q1- Amount FROM FIELD TO STORAGE in [ton]_____

Field,Storage,Biomass_type,Biomas_form,For_CHIPS,For_PELLETS

field_LEW_1,storage_LEW_1,willow,raw,1.30,0.00

_____ Q2- Amount FROM STORAGE TO SIDETRACK in [ton] _____

Storage,Sidetrack,Biomass_type,Biomas_form,Amount

storage_LEW_1,LEW,willow,chips,1.00

_____ Q3- Amount FROM SIDETRACK TO DESTINATION in [ton] ____

Sidetrack,Destination,Biomass_type,Biomas_form,Amount

LEW, Siechnice, willow, chips 1.00

_____ ENERGY EMBEDED TILLAGE & CONVERSION in [GJ] _____

Field,Storage,Biomass_type,Till,Raw_Pel,Ch_Pel,Raw_Ch,Ch_Ch

field_LEW_1,storage_LEW_1,willow,0.65,0.00,0.00,1.21,0.00

_____ ENERGY EMBEDED in TRANSPORT in [GJ] _____

Emb_transp_F_S__R =0.08
Emb_transp_F_S__Ch=0.00
Emb_transp_S_Si__Ch=0.06
Emb_transp_S_Si__P=0.00
Emb_transp_Si_D__Ch=0.04
Emb_transp_Si_D__P=0.00

_____ TOTAL ENERGY EMBEDDED in [GJ] _____
Total energy embedded,2.03

_____ CO2 EMBEDED TILLAGE & CONVERSION in [kg] _____

Field,Storage,Biomass_type,Till,Raw_Pel,Ch_Pel,Raw_Ch,Ch_Ch

field_LEW_1,storage_LEW_1,willow,44.20,0.00,0.00,27.99,0.00

```
_____ CO2 EMBEDED in TRANSPORT in [kg] _____
CO2_transp_F_S__R =0.78
CO2_transp_F_S__Ch=0.00
CO2_transp_S_Si__Ch=4.50
CO2_transp_S_Si__P=0.00
CO2_transp_Si_D__Ch=1.15
CO2_transp_Si_D__P=0.00

_____ TOTAL CO2 Emissions in [kg] _____
Total CO2 emissions 78.62
```

In order to read more easily the results, we exported these results in an Excel file. The results are thus in an Excel table.

	A	B	C	D	E
1				chips	pellets
2	LEW	Siechnice	willow	176	
3	LEW	Siechnice	maize	44	
4	JAW	Wroclaw	maize		75
5	IMG	Wroclaw	willow		75
6					

Figure 12: results exported in Excel.

To export the results, we had to use the following code (an example for energy embedded in tillage):

```
file Results_energy/ 'C:\gams\Results_energy.xls'/;

execute_unload "results.gdx" en_embed_Tillage.l

execute 'gdxxrw.exe results.gdx o=results_energy.xls var=en_embed_Tillage.l '
```

First of all, we had to give a name to our file and to determine where will be. After, we had to determine which parameter we want to exported in Excel.

After that, the results can be presented such below for each scenario i.e. L, M, H for delivery of one ton of chips in order to analyze the results.

	Energy embedded [GJ]		
Process	**Low**	**Medium**	**High**
Tillage	0,38	1,05	1,73
Conversion	1,14	1,23	1,31
Transport	0,18	0,18	0,18
Total	1,7	2,46	3,22

Table: results energy embedded for each scenario

	CO_2 emissions embedded [kg]		
Process	**Low**	**Medium**	**High**
Tillage	32,21	44,14	55,97
Conversion	12,6	27,63	42,67
Transport	6,43	7,08	7,73
Total	51,24	78,85	106,37

Table: results CO2 embedded for each scenario

We launched the GAMS software for a very accurate model used by EDF Polska. This model is called BioLOG.

Above, the model we have studied:

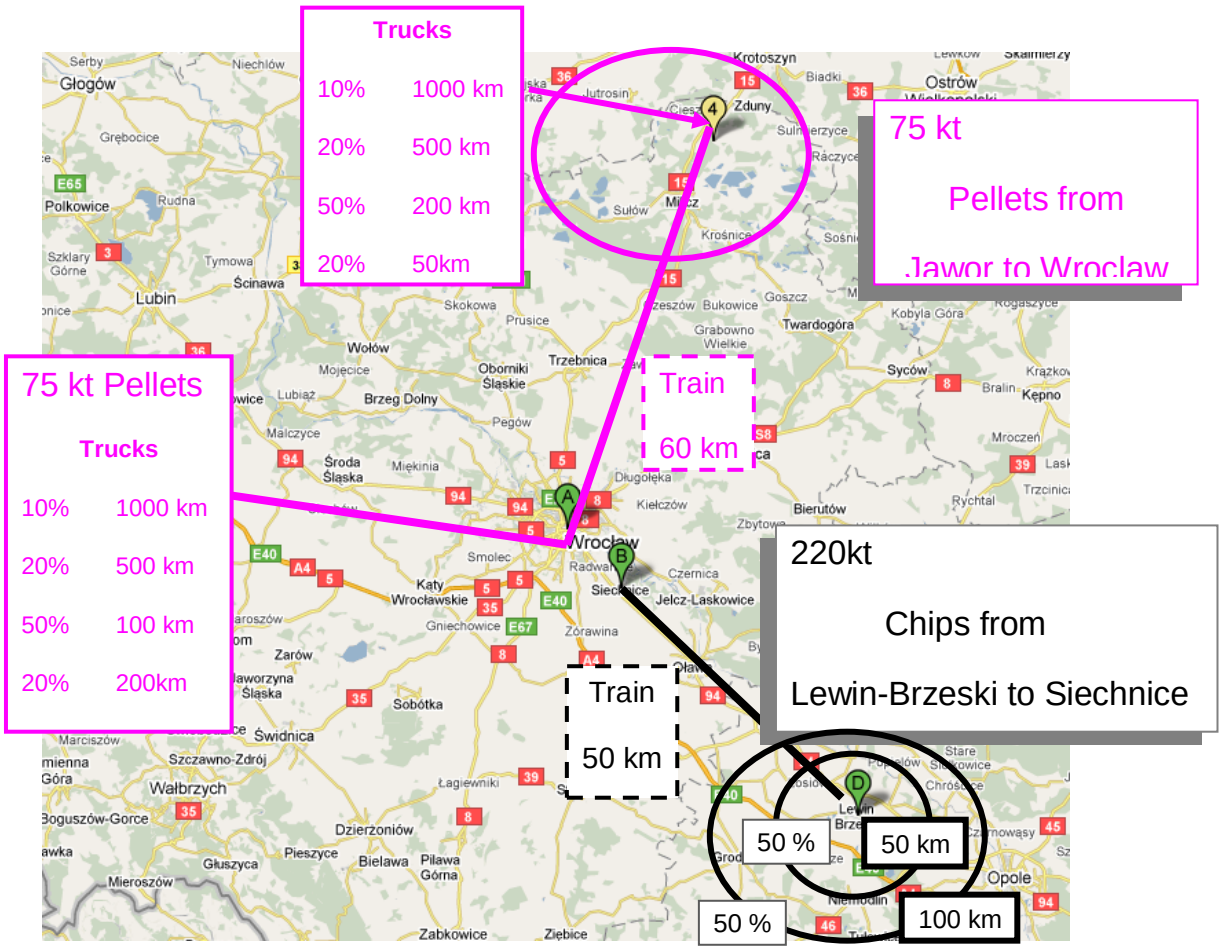


Figure 13: Biomass delivery plan to EC Wrocław and EC Czechnica **[4]**

BioLOG was used to calculate the energy and CO_2 emissions embedded in biomass delivery to EC Wrocław and EC Czechnice. The following assumptions have been made:

- **EC. Czechnica**

220 kt of chips will be delivered to the city of Siechnice by train from sidetrack located in Lewin Brzeski. Biomass will be delivered by trucks from two storage places in

equal amounts. These storage places are located 50 km and 100 km from the sidetrack. The chips will be made in 80% from willow and in 20 % from maize.

- **EC. Wrocław**

150 kt of pellets will be delivered to the city of Wrocław. 75 kt of pellets will be delivered by trucks to the sidetrack and by train to the destination place. Another 75 kt of pellets will be delivered to EC Wrocław directly with the use of heavy duty vehicles from storage places located 100, 200, 500, and 1000 km away. It was assumed that 50% of pellets will be produced from willow and 50% from maize.

Then, we ran GAMS for the different places and the entire model to calculate the energy embedded and the CO2 embedded. Here are the results:

	Energy embedded [TJ]		
Process	**Low**		**High**
Tillage	353,80	672,30	990,82
Conversion-chips	306,61	326,19	345,79
Conversion-pellets	275,26	443,26	611,26
Transport	123,39	123,39	123,39
Total	1059,06	1565,14	2071,26

Table: Total energy embedded in delivery of biomass to EC. Wrocław and Czechnica. **[4]**

	CO_2 emissions embedded [t]		
Process	**Low**		
Tillage	17671,52	21153,26	24599,14
Conversion- chips	3035,01	7026,64	11018,26
Conversion -pellets	4275,00	4275,00	4275,00
Transport	6637,34	6435,84	6637,34
Total	31215,87	38890,74	46529,74

Table: CO_2 emissions embedded in delivery of biomass to EC. Wrocław and Czechnica. **[4]**

Then, we calculated the efficiency for the different places and for the entire model. For this, we used the following formula:

$$\eta_n = \frac{E - PE}{E}$$

Where:

η_n - Energy carrier efficiency,

E – specific energy content in the energy carrier (heat value),

PE – specific energy of biofuel production process.

So we had to do research in scientific journals to find the different values of heat value for pellets and chips.

	Heat Value (MJ/kg)
Willow chips	14
Maize chips	14,5
Willow pellets	17,5
Maize pellets	17,9

Table: Heat value

After we calculated the energy delivered and, with GAMS, the energy embedded. Then, we applied the formula above and we found the following efficiency:

	Efficiency
Lewin to Siechnice	0,84
Jawor to Wroclaw (with train)	0,78
IMG to Wroclaw (without train)	0,80
Total	0,82

Table: Efficiency for the BioLOG model

4-Optimisation

Once the bulk of the work done, we tried to optimize the model or make it more pleasant to view and use.

Creating a logo

For aesthetics and to get a hallmark for our model, we created a logo that we put on the graphical user interface.

We created several logos in order to have a wider choice (Appendix 2). We used tw o software: Photoshop and PhotoFiltre. Once completed, we proceeded to a vote with all members of the office. The logo finally chosen is:

Figure 14: Logo for our model

Adding new parameters

After running the BioLOG model for two types of biomass, willow and maize, we decided to optimize this model by adding new types. We searched for straw. We had to read scientific journals and do research on the internet to find the energy embedded and CO2 embedded for each stage before the burning of biomass (Tillage, drying, transportation, conversion ...). Once all found, we have added this set (straw biomass) to GAMS software in order to expand the scope of use of this software. Subsequently, other types of biomass will be taken into account, such as

the wheat or rape, but also new forms of biomass, such as briquettes. In conclusion, further research is needed to still improve this BioLOG model.

III/ ASSETS AND PERSONAL IMPRESSIONS

This technician internship has given me the opportunity to learn more about the research engineer, the relationship between colleagues and with the boss. This is an advantage because I will less apprehensive of the engineer assistant internship next year. Indeed, the good atmosphere in the team suggests that it is possible to work while having a sincere friendship and mutual support between colleagues.

The first day our training, our boss came to get us (the others students and me) in our dorm, in order to bring us to our workplace. Then, he introduced us to his team which consists of three persons. The reception was very warm and we felt immediately at ease.

The good communication between colleagues understands that the work is done without pressure and there is no competition between members of the team. This is thanks to the boss listen to everyone. He lets his team take some initiative and in the same time, he is coaching and motivating it. Each staff person can ask questions to the boss or to the other group member, which allows to work with a free spirit and without fear of reproach.

The course also enabled me to understand how we have to work for a company like EDF. Indeed, the model on which we worked during our internship was intended to EDF Polska. During this period of internship, we produced a report highlighting the results we had obtained and the progress that was needed to make the model useful. Through this work, we have done with all team members, we found that the report had many resemblance to a validation report of a project as we done in second year at the school. Each team member had made a party of this report, and the aim of this document was to sell the project and show to EDF Polska, that it was feasible and had a real interest.

During our training, we have also attended several meetings for the presentation of our work. We had demonstrated our superior the advancement of our work, but also explain to other team members the benefit of the work, because we did not work all

the same part of the project, and it was necessary that each knows the work of others. These meetings were relaxed but framed so that everyone can speak and be heard.

This internship was an opportunity to learn the operation of other software: GAMS. Indeed, the first work we have done was to familiarize ourselves with this software. We were able to confront us what could be the environmental engineering profession in research, know the important points that must be taken into account when we want to reduce CO2 emissions. The cost of a process (for us, pelletizing, drying ...) bears to the total of the hours of work done to it, and the speed of this process are as important as the reduction of CO2.

I was also surprised at the difference of environmental problems in different countries. In Poland, the main problem is that the electricity comes mainly from coal, which emits much CO2. Bioelectricity is an interesting alternative for Poland, while nuclear energy seems to be a solution for France.

I think the work we have done during this training has been useful, what is rewarding, and that kept me motivated throughout the training period. It was the first time for me that I was going abroad for a long duration and in order to work. Although language was a barrage at the beginning, the fact that we have only English to communicate, forced me to speak in a language other than French, and fight a little against my shyness that is a real obstacle for me. The beginning of the training was very tough because I had to concentrate on each sentence and explanation and to focus even more to answer, look for words...But I think that at the end of these 13 weeks, I have improved my English.

Moreover, thanks to our schedule, we had time to visit the city and surrounding area, which was very nice. Krakow is a city full of charm and history. There were many cultural activities that we have enjoyed. During our training, we attended the graduation of students, their departure on holiday and the arrival of tourists. The old city of Krakow has something unique and relaxing, but globalization will probably upstage this delicate balance. I hope one day return to Krakow and to discover this city to my family and my friends.

CONCLUSION

Our training has been very rewarding, both professionally and human. We have learned what is teamwork, other than at school. Having fully integrated team, working with it on the same subject, has enabled us to understand the real work of engineer-researcher in the field of environment.

Moreover, the fact that the working language is exclusively English helped us to improve and be more comfortable with the language spoken.

The internship also helped us realize the importance of renewable energy for a country such as Poland, which has a slight delay in this field. The aim of Poland is reducing its carbon emissions to fulfill Kyoto Protocol. We understand well that it is real work and challenge for Poland, but this country strives to achieve its goal.

Finally, the second training, more close to the engineering profession than our first internship, we will calmly deal with our third internship as an assistant engineer, because it showed the operation of this job.

APPENDIX 1: Scientific journal where we sought the necessary data

EMISSIONS OF CO2 FROM BIOMASS PRODUCTION AND TRANSPORTATION IN AGRICULTURE AND FORESTRY – BÖRJESSON - 1996

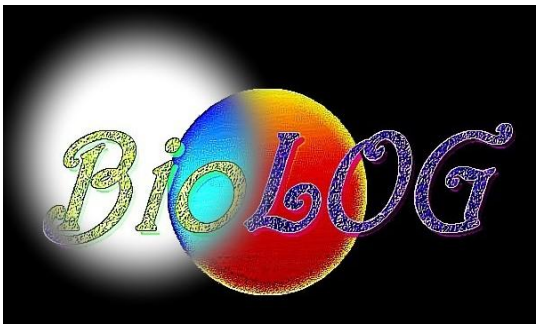
APPENDIX 2: Various proposed logos for the BioLOG model

BioLOG

BioLOG

BioLOG

BioLOG


BioLOG

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REFERENCES TABLE

Web sites:

[1] http://home.agh.edu.pl/~ppsn/images/agh_main_building.jpg

[2] http://www.agh.edu.pl/en

[3] http://www.edf.com/

[4] R&D Project Report - Optimizing Environment Protection Investments of EDF Polska Companies to Meet the Sustainable Development criteria (ENVIRO PROJECT) – Report prepared to present the work at EDF Polska

[5] http://www.gams.com/