Training session

HOW TO MAKE A TECHNO-ECONOMIC FEASIBILITY STUDY OF AN AGRO-INDUSTRY WILLING TO BECOME A LOGISTIC CENTRE

Co-funded by the Intelligent Energy Europe Programme of the European Union

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Techno-economic feasibility study

TECHNICAL FEASIBILITY…WHAT DOES IT MEAN ??

1. **Resources available in quantity and at a convenient price (€/t)**
   Security of supply (logistic chain)

2. **Compatible equipment for treatment of these resources**
   (in technical terms but also in terms of seasonality-idle periods)
   Or possibility to invest in new equipment

3. **There is a consolidated market for solid biomass**
   The market demands quality requirements that the agro-industry is able to fulfill with the equipment and type of resources

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Techno-economic feasibility study

ECONOMIC FEASIBILITY…WHAT DOES IT MEAN ??

1. **The price in the market of a similar product (in quality terms) is higher than the production costs of the product that the agro-industry is willing to generate**

2. **The product is competitive in the market (€/kWh and ash content)**

3. **The new business line is viable**

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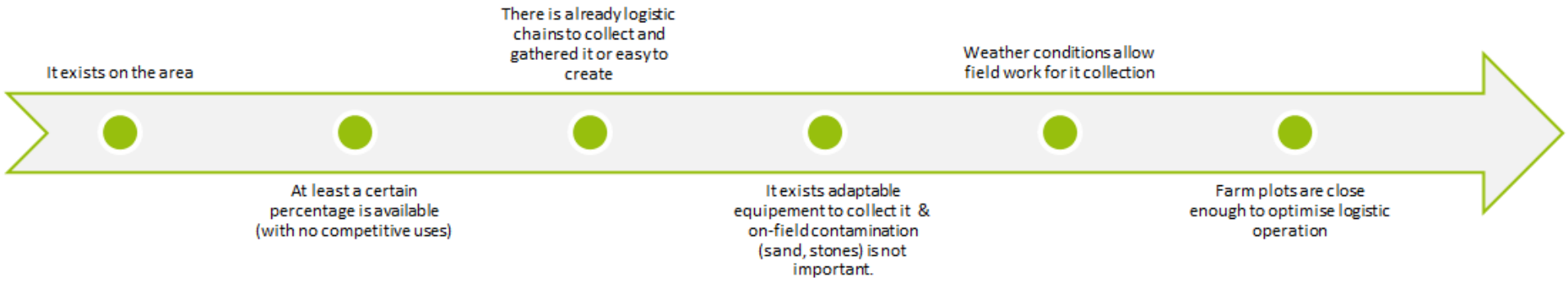
Technical feasibility – biomass resources

1. Identification of the biomass resources in the area:

MEANS SOLVING THESE QUESTIONS:

- **Which type of resources are around ?**
- **Are they available? How many t/yr in a radio of X km?**
- **Which is their price (€/t) at the agro-industry?**
- **Is their supply secure in the time?**

A resource is available in the area if:

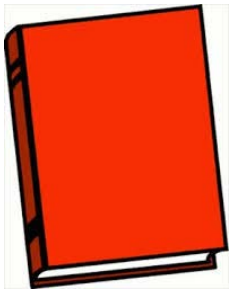


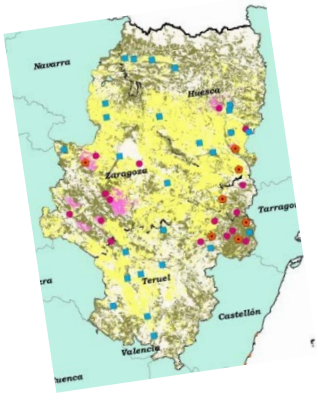
Technical feasibility – biomass resources

1. Identification of the biomass resources in the area:

Consulting…

National/regional inventories
Surveys/Databases
GIS maps





Provides you a first idea of the type of resources and their seasonality but…
CAREFUL: they can provide wrong data about AVAILABILITY !
They do not say if there is a logistic chain able to supply them!

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Technical feasibility – biomass resources

1. Identification of the biomass resources in the area:

MEET WITH THE AGRO-INDUSTRY AND ASK:

- **Which are the biomass resources around?**
- **Are they available or they have other uses?**
- **How much % of the resource is used?**
- **How many t/yr is it possible to get in a radio of < 50 km ?**
- **Is it possible to gather this resource? logistic chains already created?**
- **Which is the price (€/t) in the agro-industry (not in the field)?**
- **In which format is it going to be supplied to the agro-industry (bales, loose, bundles)?**
- **Which months it is produced?**
- **At which moisture content is collected?**

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Technical feasibility – biomass resources

1. Identification of the biomass resources in the area:

CALL SOME FARMERS (POSSIBLE SUPPLIERS OF THE RESOURCES) AND ASK:

- **How many t/yr is it possible to get in a radio of < 50 km ?**
- **Which is the price (€/t) in the agro-industry (not in the field) ?**
- **What type of contract would you make to supply it?**

Ask SEVERAL farmers to have different sources of information !
Confront this information with the one provided by the agro-industry

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Technical feasibility – biomass resources

1. Identification of the biomass resources in the area:

ONCE ANSWERED THESE QUESTIONS WE HAVE TO START THINKING ABOUT NEW ISSUES CONNECTED:

- **Which type of resources are around ? Are they herbaceous or woody (thinking about quality). Their pre-treatment is possible in the agro-industry equipment?**
- **Are they available? How many t/yr in a radio of X km? It should be evaluated how many t/yr is the agro-industry able to process**
- **Which is their price (€/t) at the agro-industry? This price should be less than a product similar on quality in the solid biomass market!**
- **Is their supply secure in the time? What if there is non-existing logistic chain? Is the agro-industry going to create it? Do we have just one supplier (risk)?**

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Technical feasibility – market

2. Assessment of solid biomass market:

MEANS SOLVING THESE QUESTIONS:

- **Is there a real demand on solid biomass ? How is the long term prospect?**
- **Which are going to be the target consumers ?**
- **Which quality requirements should be fulfilled ?**

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Technical feasibility – market

2. Assessment of solid biomass market:

CALL EXPERTS (university, biomass association, boiler manufacturers, boilers installers, …) AND ASK:

- **Which is the main biomass demand in the area ?**
- **Is there a long term prospect ?**
- **Which type of consumers are present in the area (households, agro-industries, farms, large consumers) ?**

For each type of consumer:

- **What format of solid biomass is consumed ?**
- **Which is the price (€/t or €/kWh)?**
- **Which is the quality requirement demanded (LHV and ash content)?**
- **Are boilers prepared for agro-fuels? Which are the quality constrains?**
- **Is there any national limitation for the use of our resource ?**
- **Do you think there will be a problem for feeding our resource in the consumer's boiler?**

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Technical feasibility – market

2. Assessment of solid biomass market:

OBTAIN CONCLUSIONS about the type of solid biomass that the agro-industry should produce taking into account:

- **The format demanded**

Format of products consumed by the target consumer	Compatible formats for this boiler	
Granulated products: pellets, pits, shells	Pellets Pits, shells Chipped cobs	
Chips	Chips Pellets	Pits, shells Chipped cobs
Powder (pulverised)	Powder (pulverised)	

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Technical feasibility – market

Main formats of the solid biomass:

Pellets:

Densified biofuel made from pulverised material with cylindrical form and broken ends.

The raw material to produce pellets can be woody, herbaceous or fruit biomass (or their mixtures/blends).

Typical dimensions: diameter from 6 mm to 25 mm, length from 5 mm to 40 mm.

Briquettes:

Densified biofuel similar to pellets but with larger dimensions of typically 25 mm diameter and variable length.

Source: http://www.briquetas.org/.

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Technical feasibility – market

Main formats of the solid biomass:

Chips: Pieces of wood with a defined particle size and shape produced by mechanical treatment with sharp tools such as knives.

The raw material to produce chips can only be woody biomass.

Hog fuel: Crushed/shredded wood in the form of pieces of varying size and shape and produced by crushing with blunt tools such as rollers, hammers or flails.

The raw material to produce hog fuel can only be woody biomass.

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Technical feasibility – market

Main formats of the solid biomass:

Bales:

Herbaceous or woody material compressed and bound to squares or cylinders.

Typical volume is 0,1 and 3,7 m^3 for square bales and 2,1 m^3 for cylinder bales.

Fruit stones/kernel:

By-products and residues coming from the fruit processing industry with a typical particle size of 5 to 15 mm.

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Technical feasibility – market

2. Assessment of solid biomass market:

OBTAIN CONCLUSIONS about the type of solid biomass that the agro-industry should produce taking into account:

- **The type of resource available:**

woody biomass = high moisture, low ash content
herbaceous biomass = low moisture, high ash content, high chlorine levels

Bear in mind that:

- **How can reduce moisture content?** — **Drying system needed**
- **How can we reduce ash content ?** — **PROBLEM: only possibility, taking care of exogenous material during harvesting**
- **How can we reduce chlorine levels?** — **PROBLEM!! Only washing the resource but you increase moisture content**

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Technical feasibility – market

2. Assessment of solid biomass market:

Average quality values of resource according to ISO 17225-1

Resource	LHV (kJ/kg db)	A (w-% db)	Cl (w-% db)
Soft wood stem	19,1	0,3	0,01
Soft wood logging residues	19,2	3	0,01
Cereal straw	17,6	5,0	0,40
Corn cobs *	16,5	1,0-2,0	0,02
Grape pomace	19,0	6,0-13,0	0,03-0,18
Olive pomace	13,9-19,0	3,4-11,3	0,1-0,4
Olive pits	17,3-19,3	1,2-4,4	0,10-0,40
Rice husks	14,5-16,2	13,0-23,0	0,03-0,30

These are average values obtained from experience in scientific work !!

These vales can be different than yours!

(*MixBioPells project)

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Technical feasibility – market

2. Assessment of solid biomass market:

Compare the resources quality values that you have with the quality values demanded by the consumer !

Is it possible to achieve market demands?

If the format desired is a pellet, sometimes is possible to upgrade the quality

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Technical feasibility – market

2. Assessment of solid biomass market:

- Cereal straw products **are not so good from the quality point of view (high ash content)** and should be mixed with wood in order to make an agro-pellet according to ISO 17225-6 A **(max ash content 6 w-% db)**

AVAILABLE RESOURCES	LHV ar (kJ/kg)	Ash content (w-% db)	Ash fusion temperature (°C)	N (w-% db)	Cl (w-% db)
cereal straw	15,0	4,4-7,0	800-900	0,30-0,80	0,03-0,05
Mixed straw (70%) wood (30%) pellets	15,5	< 5,11	To declare	0,30-0,65	0,04
Agro-pellets ISO 17225-6 A	≥ 14,5	< 6,0	To declare	< 1,5	< 0,1

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Technical feasibility – market

2. Assessment of solid biomass market:

Calculations on mixing are based on mass balances!

They are a theoretical approach based on limits stated by the standard

The best is to test real products in the target consumer equipment

Real conclusions about the suitability of our product will be achieved

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Technical feasibility – market

2. Assessment of solid biomass market:

MEET WITH THE AGRO-INDUSTRY AND DISCUSS ABOUT:

- **Is there any target consumer already ?**
  How much and when is the demand?

- **Inform about the conclusions obtained from the conversation with experts.**
  Does the agro-industry see any obstacle?

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Technical feasibility – market

2. Assessment of the biomass market:

ONCE ANSWERED THESE QUESTIONS WE HAVE TO START THINKING ABOUT NEW ISSUES CONNECTED:

- **Is there a real demand on solid biomass ? How is the long term prospect ? The idle period of our facility, the period when the raw material is produced and the demand period matches?**
- **Which are going to be the target consumers ? How much solid biomass do they consume?**
- **Which quality requirements should be fulfilled? Is it possible to achieve them with the resources we have?**

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Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

MEANS SOLVING THESE QUESTIONS:

- **Which type of equipment is existing? Is it compatible with the type of resources?**
- **Is the idle period compatible with the seasonality of the products?**
- **Which is the capacity of the whole system in the idle period?**

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Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

Technical compatibility -> Essential equipment to be evaluated:

- **CHIPPER or GRINDER: to reduce particle size. It is normally the first step of the pre-treatment**
- **DRIER: if the desired product should have a lower moisture content than the resource. Drying is needed for pelletising in most of resources (unless they are around 13 w-%, ar)**
- **PELLETISER: only if the final product is a pellet**
- **SCREENER: interesting to eliminate fines in any type of product (increase quality)**
- **STORAGE: silos, outdoor storage or warehouses. Key point for agro-industries.**

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Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

Technical compatibility -> Essential equipment to be evaluated:

Raw material	Pre-treatment needed	Product
Cereal straw (15 w-%, ar)	Grinding Milling+pelletising	Pellet (10 w-% ar)
Maize stalks (25 w-%, ar)	Grinding Drying Milling+pelletising	Pellet (10 w-% ar)
Vineyard prunings (35 w-%, ar)	Chipping Drying Screening	High quality wood chips (20 w-%, ar)
Olive prunings (35 w-%, ar)	Natural drying Chipping	Hog fuel (25 w-%, ar)

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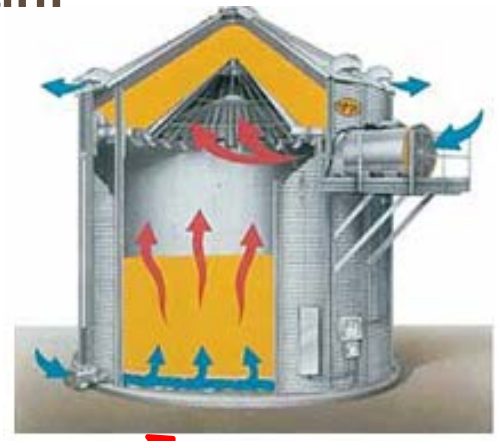
Technical feasibility – equipment

Vertical driers used for grain:



Compatible with granulated product and chips
Impossible for herbaceous

Compatible with granulated product: olive pits, almond shell, etc.
Difficult with chips. Impossible for herbaceous

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Technical feasibility – equipment

Horizontal driers:

Rotatory: Compatible with all types of formats: granulated, chips and herbaceous

Belt: Compatible with formats: granulated and chips

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Technical feasibility – equipment

Pelletiser:

Designed for herbaceous but compatible with woody resources but…the production can be even ½ of the herbaceous if the dye is not adapted!

Remember that the goal of making a pellet/bale is to increase the density in order to decrease transport costs and improve handling…

A pellet or a bale are the only format possible when the resource available is herbaceous

To pelletise an olive pit or an almond shell has no-sense!!! They are already densified products!

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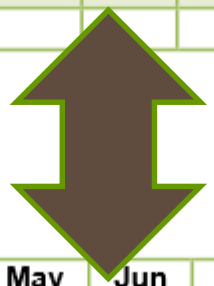
Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

Seasonal compatibility -> Essential equipment to be evaluated:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pelletiser												
Dryer												
Mill												
Chipper												
Screener												
Other, specify												



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Residue 1:												
Residue 2:												
Residue 3:												
Residue 4:												
Residue 5:												

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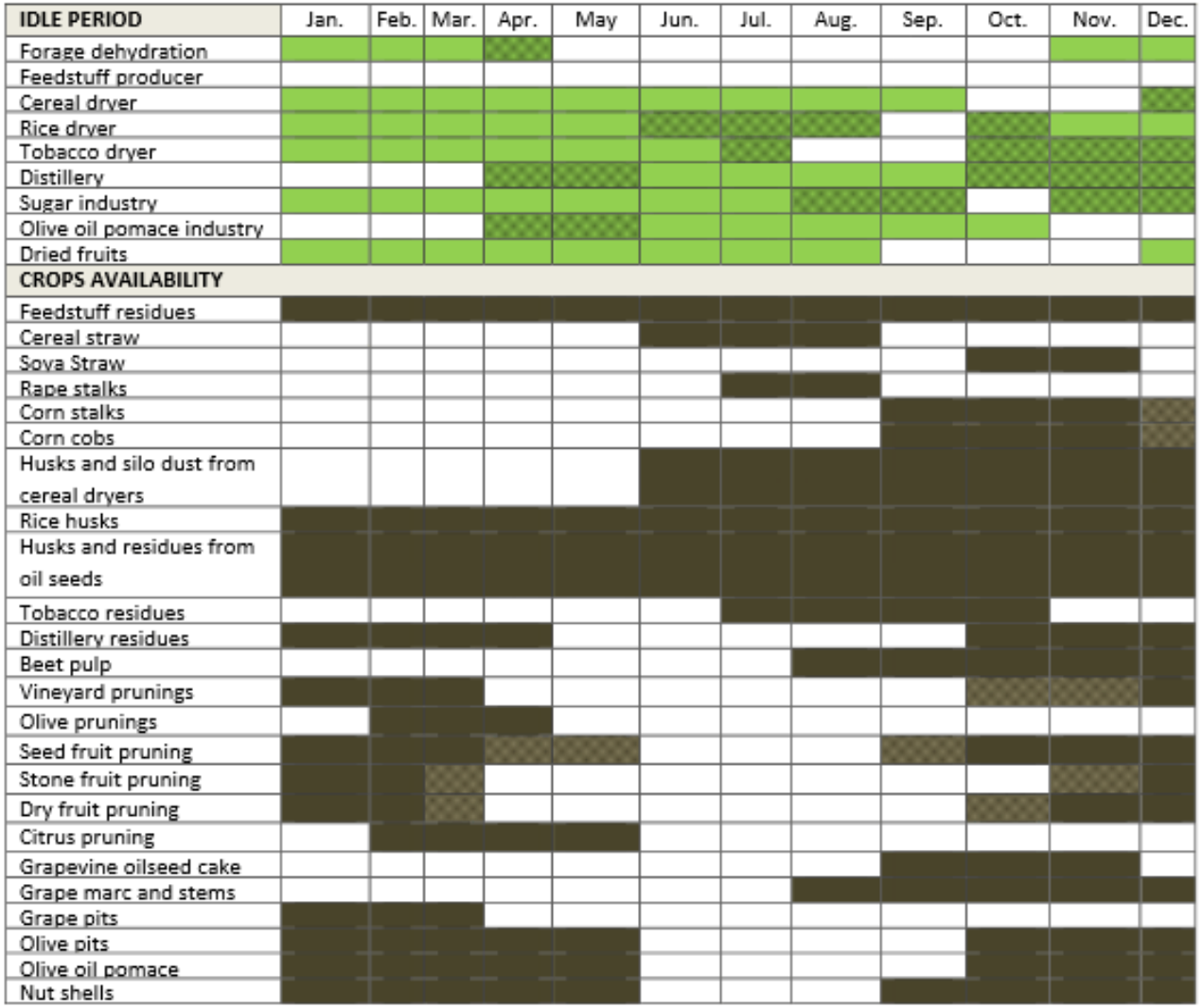
Technical feasibility – equipment

Synergies between idle period of agro-industries (green) and crops seasonal availability (brown)



Periods where facilities equipment used to be idle

Periods when the biomass is produced by harvest or processing activities

Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

Assessment of the capacity for the new resource:

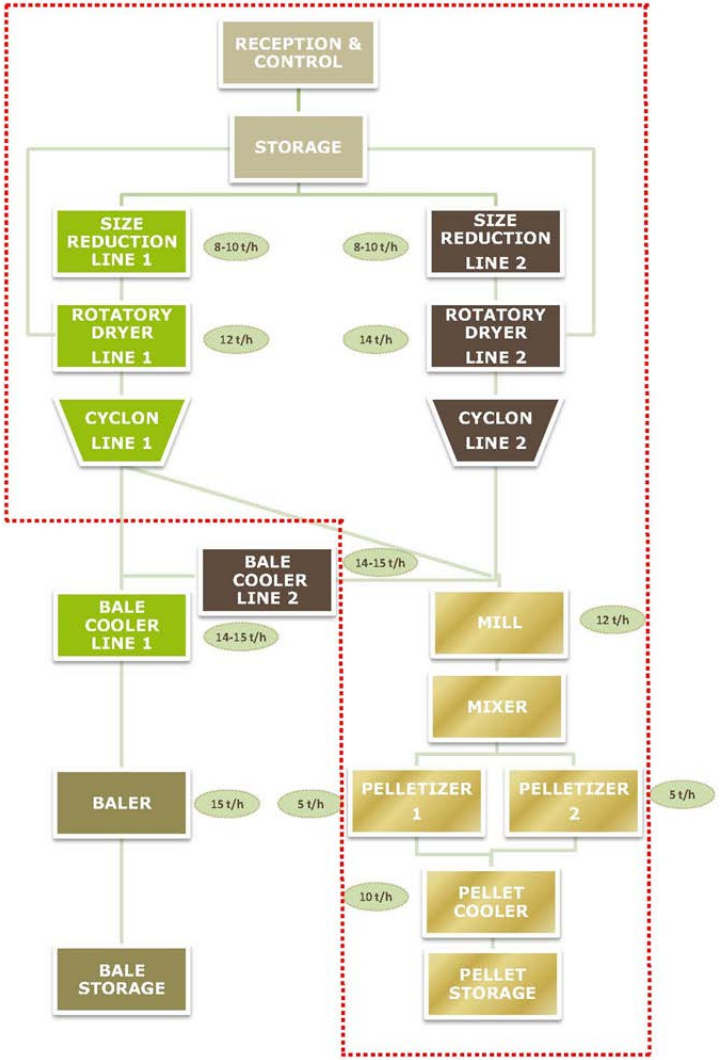
Example from a real case of forage dehydration facility (indicated flows for the forage). It can be observed that:

1. **The pelletiser is the bottle-neck**

2. **The maximum capacity of each whole line for alfalfa is 10 t/h.**

What would be the capacity for the new resource?
The responsible for operation will tell you!

7 t/h for cereal straw
7.5 t/h for maize stalks
5 t/h for wood



Technical feasibility – equipment

2. Evaluation of the compatibility of the equipment with the resources:

How many tons per year is the facility being able to produce with the new resource?

Possible resources

7 t/h for cereal straw
7.5 t/h for maize stalks
5 t/h for wood

✖

Idle period

HOURS/year

=

Tons / Year

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Technical feasibility – equipment

3. Evaluation of the compatibility of the equipment with the resources:

ONCE ANSWERED THESE QUESTIONS WE HAVE TO START THINKING ABOUT NEW ISSUES CONNECTED:

- **Which type of equipment is existing? Is it compatible with the type of resources?**
  Do we need some modification/adaptations for the production?

- **Is the idle period compatible with the seasonality of the products?**
  Is the storage possible (or the resource will degrade)?

- **Which is the capacity of the whole system in the idle period?**
  Does the agro-industry wants to produce so much? Does it exist enough resource for that?

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Economic feasibility

- **The aim of the economic study is to help decision-making. The economic study has no sense if the project is not technically feasible**
- **SUCELLOG has built a guide to assist you in the economic analysis. It can be downloaded in the website.**
- **It is accompanied by an excel-sheet**

CAREFUL !!! the excel cannot address all cases…
it is required that you understand the excel and play!

Different scenarios can be assessed and compared!

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Economic feasibility

Steps for the economic assessment

For an amount of production per year !!!!

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price:

The minimum selling price (€/t of product) is the price at which the logistic centre would be able to sell the product covering:

- **Production costs.**
- **Amortization rate of the investment in equipment required for production (if desired).**
- **The minimum profit stated by the agro-industry (if any).**

Include:

- **Raw material purchasing costs**
- **Pre-treatment cost**
- **Personnel cost**

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

- **Raw material purchasing costs**

1. RAW MATERIAL PURCHASING COST

SCENARIO 1

FINAL PRODUCT				RAW MATERIAL								
Expected annual production	t/yr											
Type of residues	Mixture	MC final product	Quantity for final product	MC afer storage and before drying	Quantity afer storage and before drying	MC after drying and before pelletising	Quantity after drying and before pelletising	MC raw material fresh	Quantity raw material	Price	Transportation cost	Total costs
	%	%	t	%	t	%	t	%	t/yr	€/t	€/t	€/yr
include " type raw material"			0	0	0		0		0		0	0
include " type raw material"			0	0	0		0		0		0	0
Total			0						0			0

MC: moisture content

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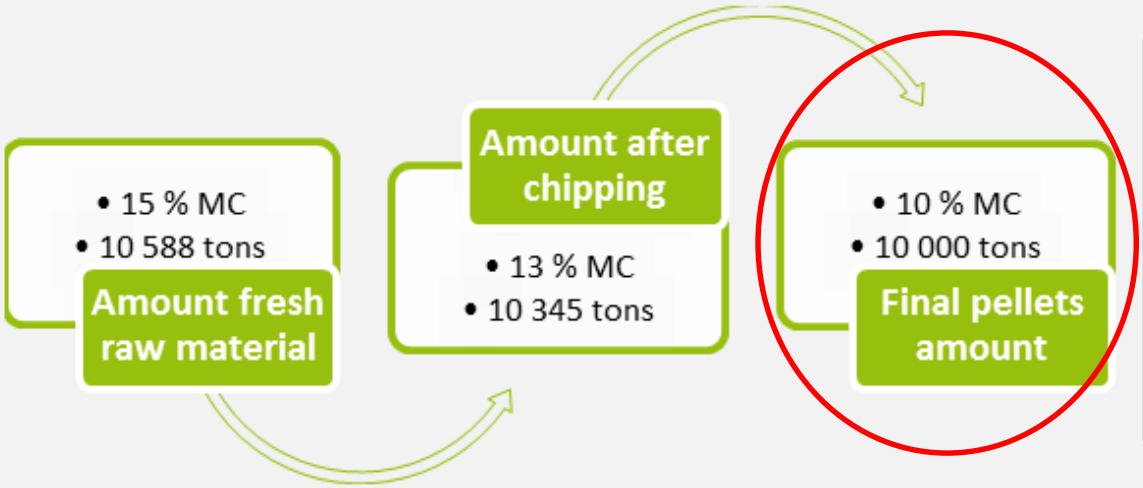
Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

- **Raw material purchasing costs**

Moisture content is a key factor!!!!!!!!!! The % variates with the pre-treatment process meaning that the amount of material to be pre-treated changes!



$$Dry\ matter = final\ amount - final\ water\ amount$$

$$\Leftrightarrow Dry\ matter = final\ amount\ (1 - {}^{MCfinal}/_{100})$$

$$\Leftrightarrow Final\ amount = \frac{Dry\ matter}{(1 - \frac{MCfinal}{100})}$$

$$\Leftrightarrow \boldsymbol{Final\ amount = Initial\ amount\ \frac{(100 - MCinitial)}{(100 - MCfinal)}}$$

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

- **Pre-treatment costs:**

Think which is the quality and format of the solid biofuel you want to produce… and the characteristics of the raw material …

TYPE OF PRE-TREATMENT NEEDED

IMPORTANT

The higher the quality of the product, the more pre-treatment needed

The evaluation of cost should be done with the agro-industry !!!! Not comparable to others (or other countries) !!

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

Raw material	Pre-treatment needed	Product
Cereal straw (15 w-%, ar)	Grinding Milling+pelletising	Pellet (10 w-% ar)
Maize stalks (25 w-%, ar)	Grinding Drying Milling+pelletising	Pellet (10 w-% ar)
Vineyard prunings (35 w-%, ar)	Chipping Drying Screening	High quality wood chips (20 w-%, ar)
Olive prunings (35 w-%, ar)	Natural drying Chipping	Hog fuel (25 w-%, ar)

Operational costs
(electricity; heating; manpower)
Maintenance costs
(consumables ; manpower)

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

Maintenance costs:

personnel consumables

MAINTENANCE COSTS	Include "Type of raw material"				
Type of operation	Hours spent in maintenance h	Cost of replacement €	Tonnes processed t/yr	Maintenance costs h/t	Maintenance costs-replacement €/t
Storage of raw material			0,00	#¡DIV/0!	#¡DIV/0!
Handling			0,00	#¡DIV/0!	#¡DIV/0!
Particle size reduction			0,00	#¡DIV/0!	#¡DIV/0!
Drying			0,00	#¡DIV/0!	#¡DIV/0!
Milling + pelletizing			0,00	#¡DIV/0!	#¡DIV/0!
Storage of final product			0,00	#¡DIV/0!	#¡DIV/0!

Think on the maintenance cost for the new material !!
Example: the die for forage can be changed every 4000 t while with maize stalks every 2000 t

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

Operational costs: Think on the cost for the new material !!

OPERATINAL COSTS: HEATING COSTS			
Type of operation	Include "Type of raw material"		
	Fuel consumption t or m3	Fuel price €/t or €/m3	Heating costs €
Drying			0

OPERATIONAL COSTS: ELECTRICITY COSTS	
Type of operation	Include "Type of raw material"
	Electricity costs €/t
Storage of raw material	
Handling	
Particle size reduction	
Drying	
Milling + pelletizing	
Storage of final product	

OPERATIONAL COSTS: PERSONNEL	
Type of operation	Include "Type of raw material"
	Spent hours h/t
Storage of raw material	
Handling	
Particle size reduction	
Drying	
Milling + pelletizing	
Storage of final product	

Sometimes you cannot disaggregate, modify the excel accordingly!

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

Operational costs: Think on the cost for the new material !!

What if the agro-industry does not know the costs for the new material ??
Extrapolate cost with the capacity of the facility.

Example:

Regular operation: 7 t/h forage
Cost drying: 14 €/t (from 35 w-%, ar to 12 w-%, ar)
Cost grinding+ milling+pelletising: 15 €/t

we assume that although initial MC is lower, the fibre is tickerr and more complicated to dry (conservative)

New operation: 4,5 t/h maize stalks
Cost drying (from 25 w-%, ar to 14 w-%, ar) = [(7 t/h * 14 €/ h) / 4.5 t/h]
Cost grinding+ milling+pelletising: [(7 t/h * 15 €/ h) / 4.5 t/h]

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Personnel costs

MAINTENANCE*

Total salary per year	€/year	
Working hours per year	h/year	
Hourly Rate	€/h	#¡DIV/0!

OPERATIONAL*

Total salary per year	€/yr	
Working hours per year	h/yr	
Hourly Rate	€/h	#¡DIV/0!

The information here feeds the pre-treatment costs!

Do you want to charge some hours of the administrative personnel to this new business line?

SUPPORT PERSONNEL

		GENERAL MANAGER	SALES MANAGER	ADMINISTRATION DEPARTMENT	
Total salary per year	€/yr				
% spent in new business	%				
Total costs	€/yr	0	0	0	0

Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Production costs

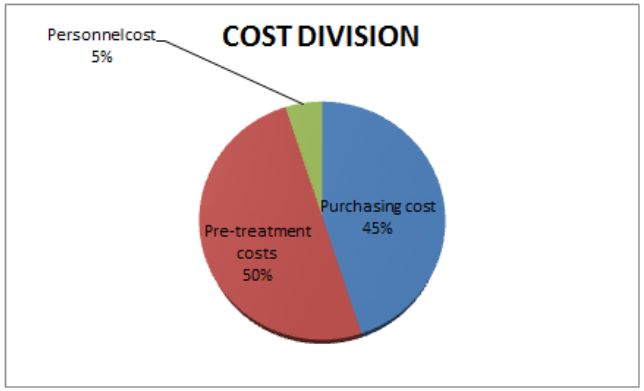
4. PRODUCTION COSTS

SCENARIO 1

Solid biomass type	Quantity produced	Total costs			Production cost
		Purchasing cost	Pre-treatment costs	Personnel cost	
	t/yr	€/t	€/t	€/t	€/t
Include "Solid biomass type"	0	#¡DIV/0!	#¡DIV/0!	#¡DIV/0!	#¡DIV/0!

Which is the one that contributes the most to the production costs?
Example:

Percentage of contribution (%)		
Purchasing cost	Pre-treatment costs	Personnel cost
45	50	5



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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price- Amortization rate & Minimum profit

5. INVESTMENT

Investment items	Investment costs €	Years of amortization yr	Amortization rate €/yr
			#¡DIV/0!

Does the agro-industry wants to charge some rate from the amortization to each ton of product?

6. MINIMUM PROFIT

Minimum profit €/t*	

Does the agro-industry wants to have a minimum profit per ton of product in order to cover possible risks ?
It can be a fixed quantity or a % of costs

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Economic feasibility– Minimum selling price

1. Determination of the minimum selling price

7. MINIMUM SELLING PRICE

SCENARIO 1						
Solid biomass type	Quantity t/yr	Production cost €/t	Transport cost* €/t	Amortization rate €/t	Minimum profit €/t	Minimum selling price €/t
Include "Solid biomass type"	0	#¡DIV/0!		#¡DIV/0!	0	#¡DIV/0!

To be able to compare with other products sometimes should be included

Is it a competitive price?

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Economic feasibility – competitiveness

2. Evaluation of competitiveness in the market

Are you competitive in terms of price-quality? Check you competitors!

QUALITY DATA FROM THE PRODUCT					
Product	LHV kWh/kg db	Ash content (w-%db)	MC final product (w-%, ar)	LHV kWh/kg ar	Minimum selling price €/kWh
			0	0	#¡DIV/0!

COMPETITORS						
Product	Price €/t	LHV kWh/t ar	Price €/kWh	Ash content (w-%db)	Transport €/t	Taxes (included or not)
			#¡DIV/0!			*included*
			#¡DIV/0!			*included*
			#¡DIV/0!			*included*
			#¡DIV/0!			

Included?

Bulk density should be also taken into account!

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Economic feasibility – Project profit

3. Assessment of project profit

4 economic indicators will be calculated and the agro-industry will decide according to them if the project is convenient

- **NPV: Net Present Value**

Indicates that the projected earnings generated exceed the anticipated costs. Generally, the higher is the NPV, the more profitable is the project.

- **IRR: Internal Rate of Return**

An investment is a good option if its IRR is higher than the rate of return that can be earned by investing the money elsewhere at equal risk (ex: bank investment).

- **Return on Sales**

Indicates how much profit an entity makes after paying for variable costs of production such as wages, raw materials, etc. (but before interest and tax).

- **Payback period**

The time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment.

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Thank you for your attention !!

We encourage you to have a look at the Handbooks and Guides produced by SUCELLOG !

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See detailed information about the techno-economic feasibility studies of real cases in Spain, France, Italy and Austria performed by SUCELLOG in the documents D4.3 available in English and national languages on the website

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CENTRO DE INVESTIGACIÓN
DE RECURSOS
Y CONSUMOS ENERGÉTICOS

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