Summerschool Biomass for Sustainable Rural Development

CHALLENGES AND OPPORTUNITIES FOR LOCAL SUSTAINABLE DEVELOPMENT OF FOREST-BASED BIOENERGY

as a result of EU cooperation:
from the idea to practice,
an example of knowledge-based low carbon bioeconomy

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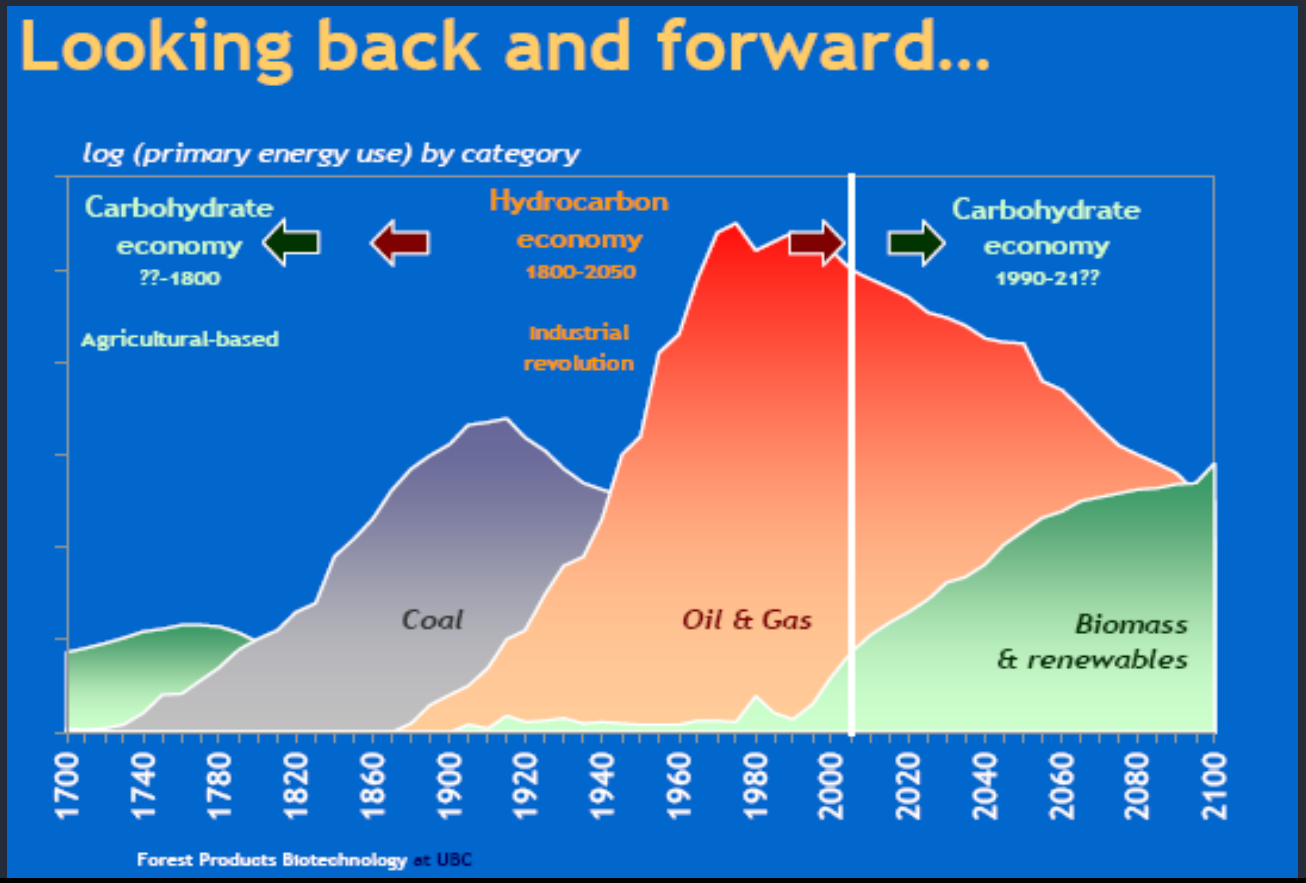
1. INTRODUCTION
2. FOREST-BASED BIONERGY
3. SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN UNDER MEDITERRANEAN CONDITIONS
4. FOREST-BASED BIOENERGY POTENTIAL IN THE COMMUNITY OF VALENCIA
5. INNOVATION CHALLENGES AND INTEGRAL BIOENERGY PROJECTS

GLOBAL ENERGY MARKET SITUATION & TRENDS



INTRODUCTION

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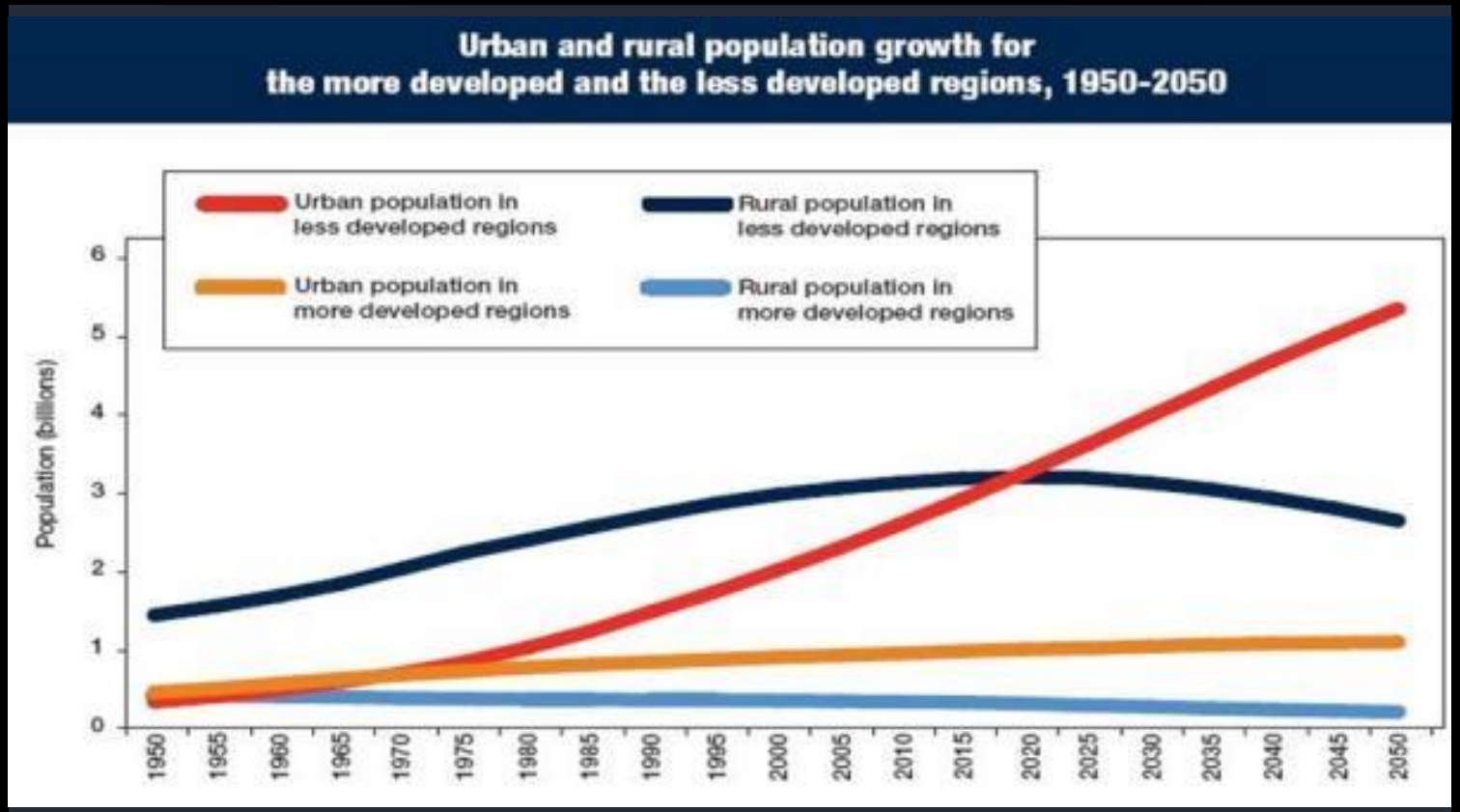

Source: FAO 2013

INTRODUCTION

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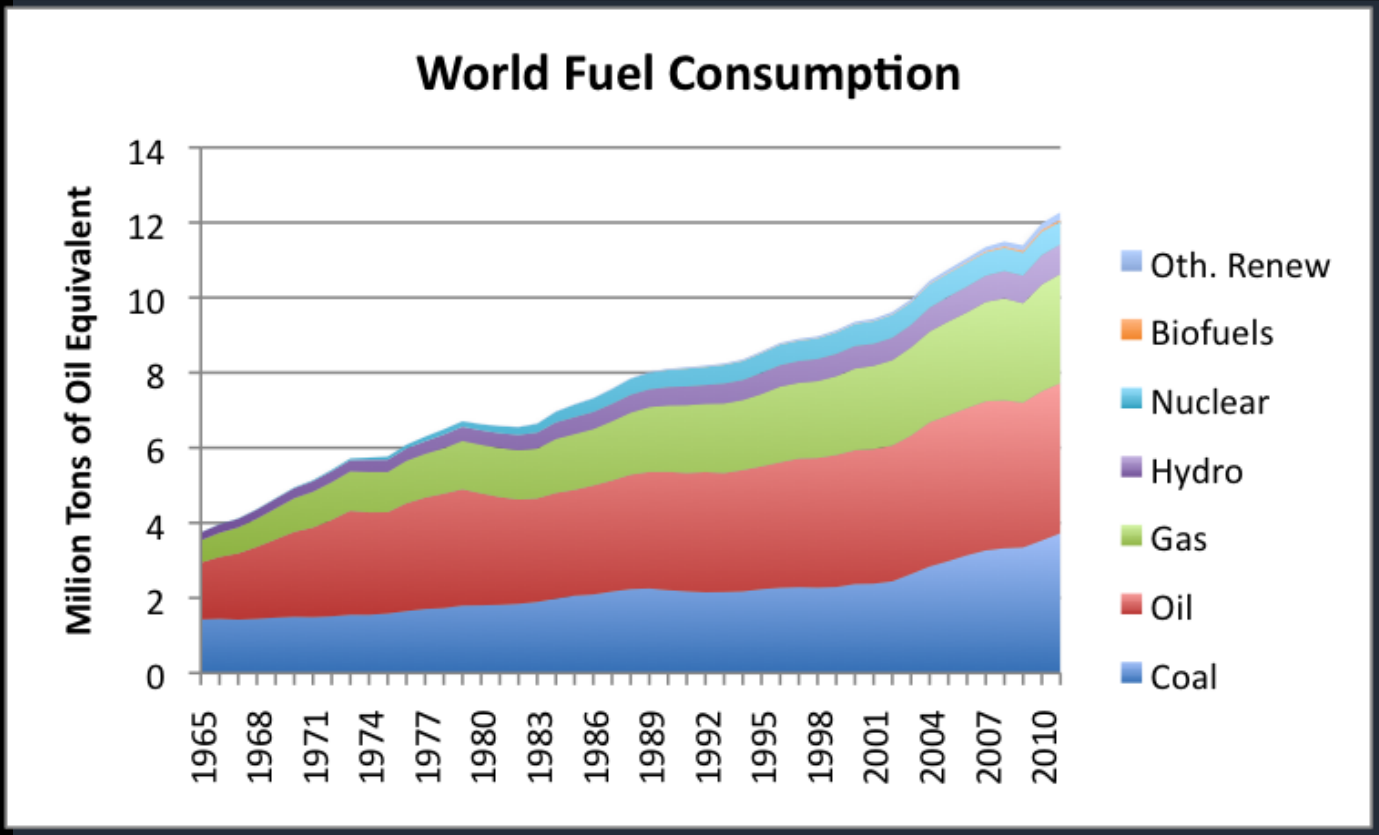

Source: FAO 2012

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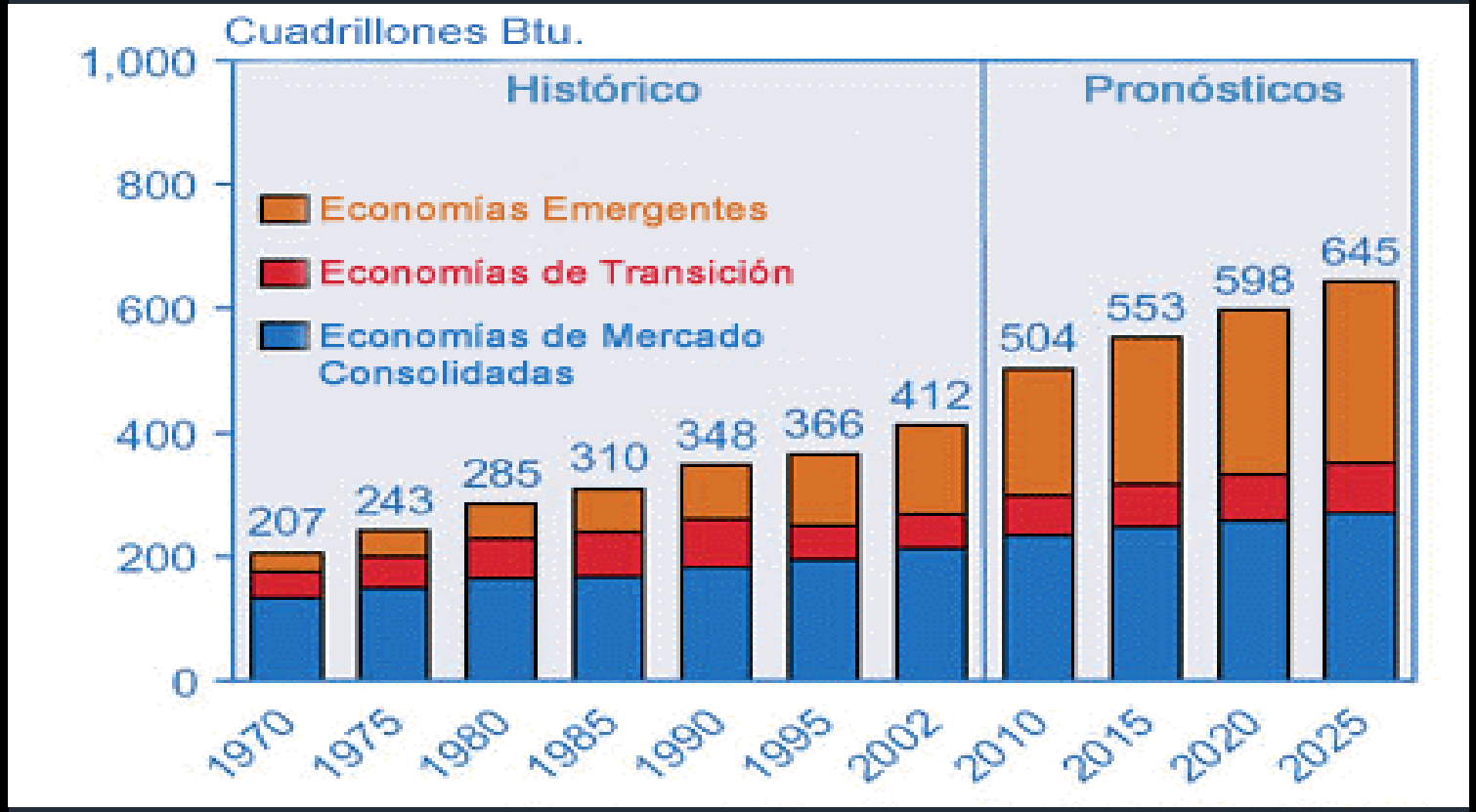
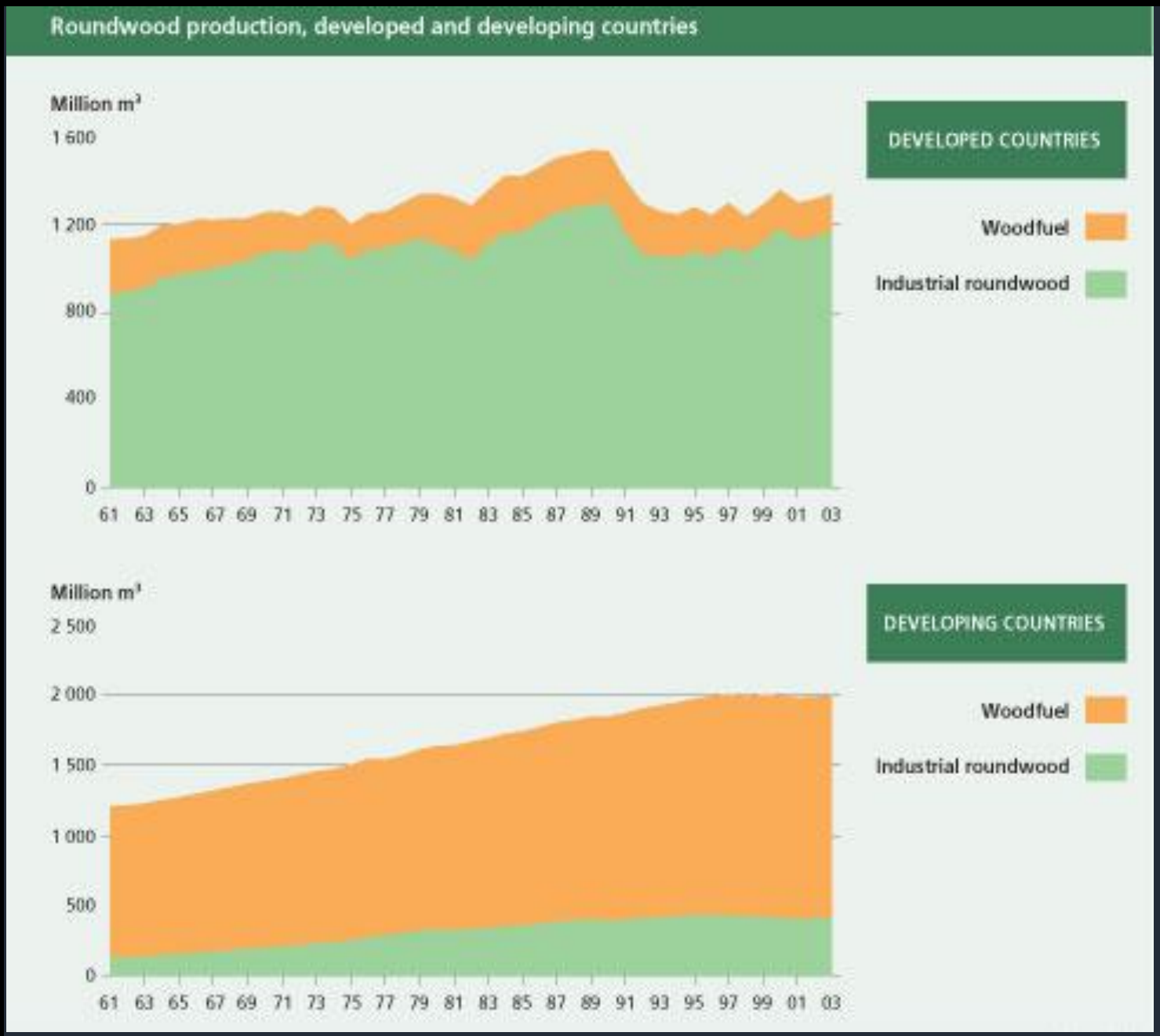


Source: EIA – Energy Information Administration Washington 2012

GLOBAL FOREST-BASED BIOMASS USE

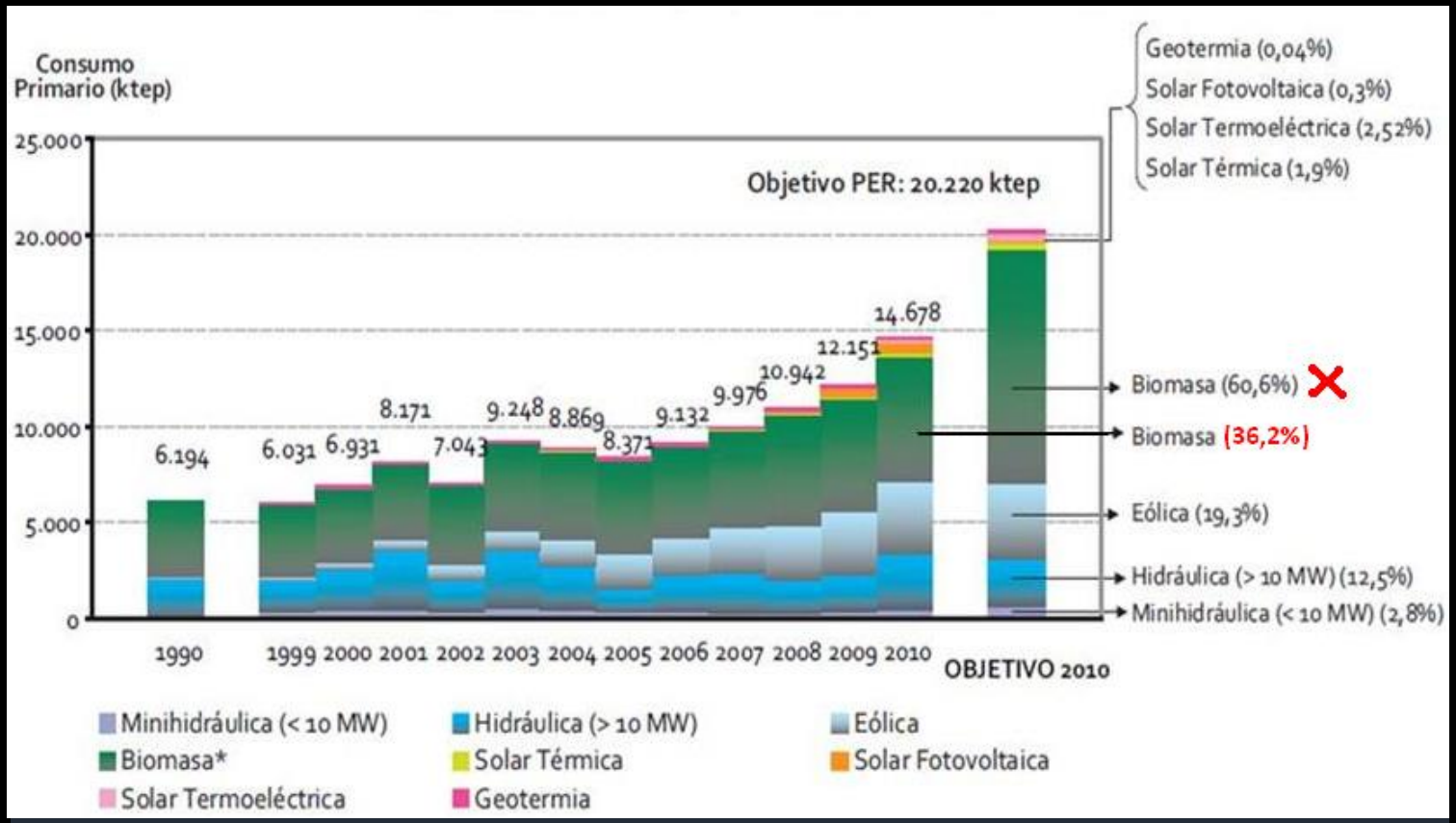
Source: FAO 2008

INTRODUCTION



Source: FAO 2008

BIOMASS POTENTIAL IN SPAIN



Source: IDAE 2010

INTRODUCTION

SUSTAINABILITY: LEARNING FROM THE PAST


Mit Gott!

SYLVICVLTVRA OECONOMICA,

Oder

Haußwirthliche Nachricht und Naturmäßige

Anweisung

zur

Wilden Baum-Zucht,

Nebst

Gründlicher Darstellung

Wie zu förderst durch Göttliches Beystehen dem allenthalben und insgemein einreissenden

Grossen Holtz-Mangel

Vermittelst Säe-Pflantz- und Versetzung vielerhand Bäume zu prospiciren

Als zu nöthiger Beförderung des Hauß- Bau- Brau- Berg- und Schmeltz-Wesens

Worbey zugleich eine gründliche Nachricht von dem Churfl. Sächs. Landen

Gefundenen Turff

Dessen Natürliche Beschaffenheit / grossen Nutzen / Gebrauch und nützlichen Verkohlung

Von

Hannß Carl von Carlowitz

Königl. Pohl. und Churfl. Sächs. Cammer-Rath und Ober-Berg-Hauptmann.

Mit Königl. Pohl. und Churfürstl. Sächs. allergnädigsten PRIVILEGIO.

LEIPZIG,

verlegts Johann Friedrich Braun 1713.

1713 – 2013: Hans Carl von Carlowitz : THE PRICIPLE OF FOREST SUSTAINABILITY

INTRODUCTION

SUSTAINABILITY: LEARNING FROM THE PAST

"For the protection and cultivation of wood for heating uses, many art, science and efforts are needed to ensure a continuous, ongoing and SUSTAINED (NACHHALTIGKEIT) use.
It is an indispensable issue without which the whole country, the persons, plants and animals are not safe."

"When forests are ruined, income for many years (50-100) are lost. The treasure is ruined. Excessive use of wood for energy is an interesting short-term benefit to our actual society, but it is a loss that can not be replaced for generations. "


Mit GOtt!
SYLVICVLTVRA OECONOMICA,
Oder
Hauß-wirthliche Nachricht und Naturmäßige
Anweisung
zur
Wilden Baum-Zucht,
Nebst
Gründlicher Darstellung/
Wie zu förderst durch Göttliches Beystehen dem allenthalben und insgemein einreissenden
Grossen Holtz-Mangel/
Vermittelst Säe-Pflantz- und Verpflantzung vielerhand Bäume zu prospiciren/
Alles zu nöthiger folger Verlegung des Haus- Bau- Brau- Berg- und Schmeltz-Wesens/
Worbey zugleich eine gründliche Nachricht von dem Churfl. Sächs. Landen
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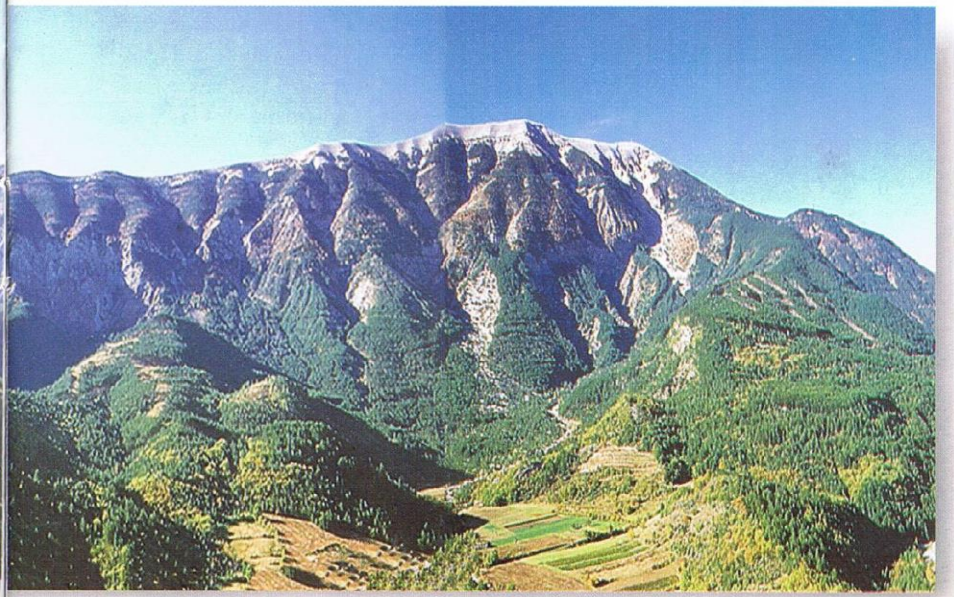
INTRODUCTION

Le Mont Ventoux au début du siècle...

... et aujourd'hui



SUSTAINABILITY: THE GLOBAL FUTURE (RIO+20)

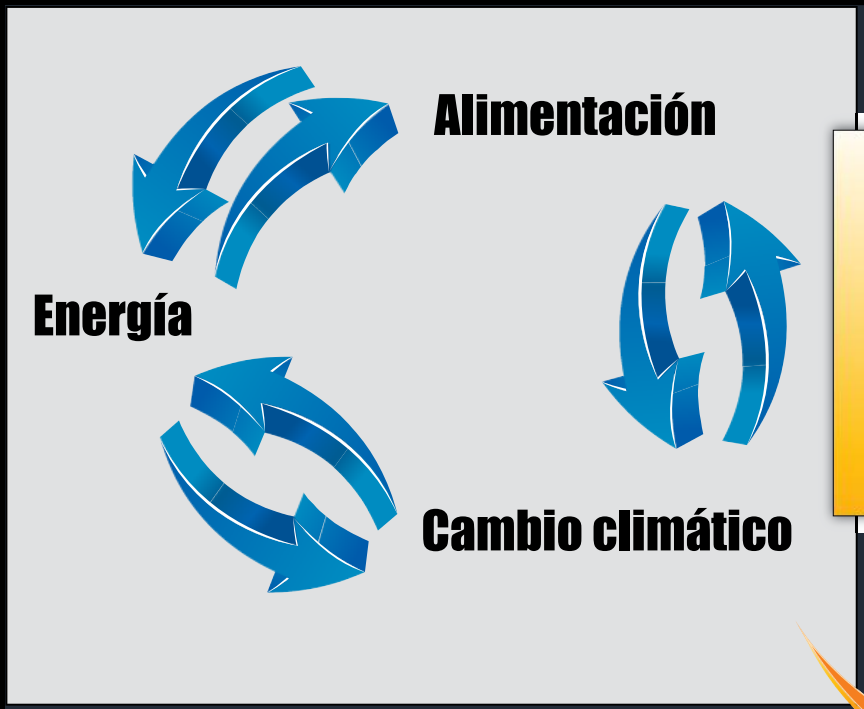
Rio+20 (2012):
WORLD CHALLENGES: THE FUTURE WE WANT

WGs:
EMPLOYMENT, NATURAL DISASTERS, FOOD, ENERGY, WATER and OCEANS

KEY LINKED ELEMENTS:
CLIMATE CHANGE, BIODIVERSITY, GREEN ECONOMY, HEALTH and FORESTS

FORESTRY:
Voted as 2nd environmental global challenge (after climate change)
(after complete failure of Rio 1992)

SUSTAINABILITY: THE GLOBAL FUTURE (RIO+20)

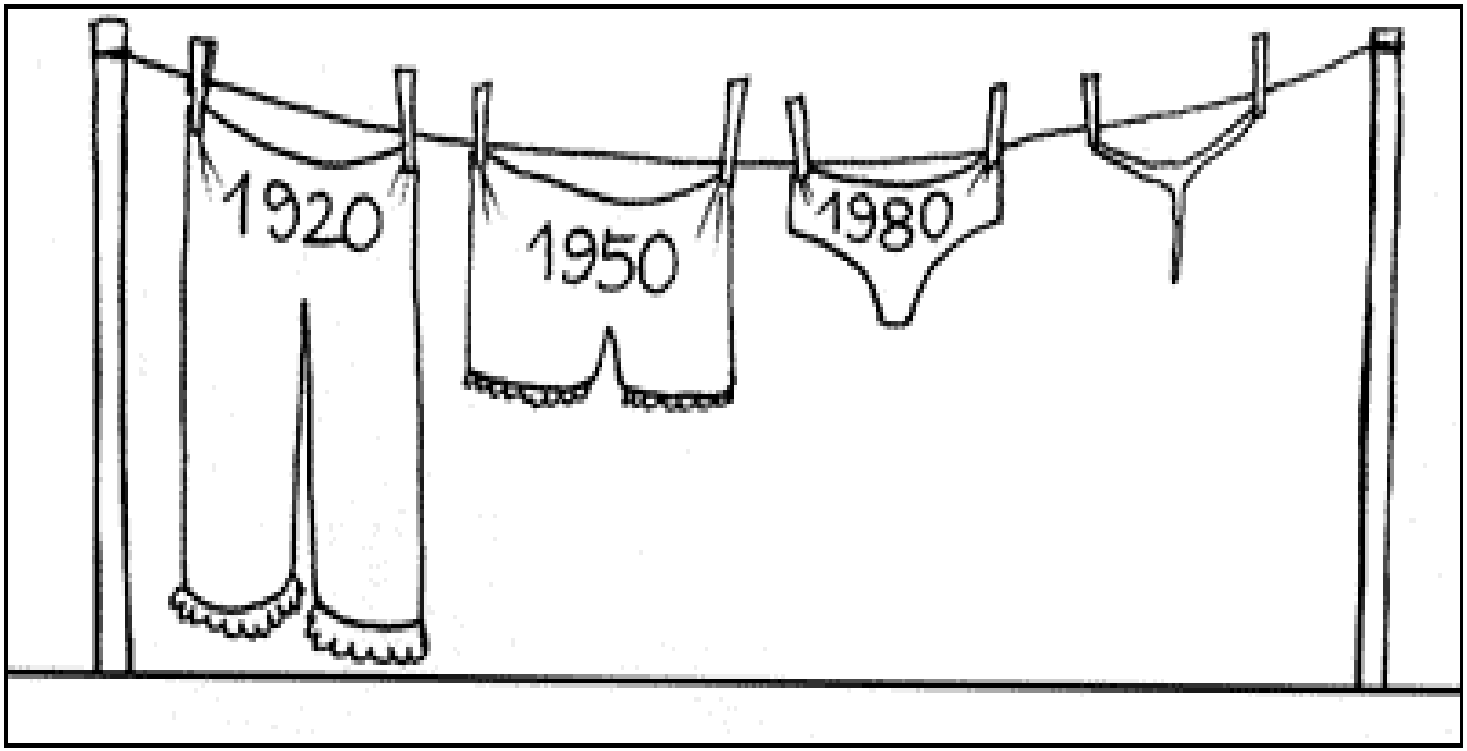


Cambios demográficos:
Crecimiento demográfico en moderación
Urbanización
Envejecimiento
Migraciones

3 MAIN CHALLENGES

INTRODUCTION

SUSTAINABILITY: TACKLE CLIMATE CHANGE



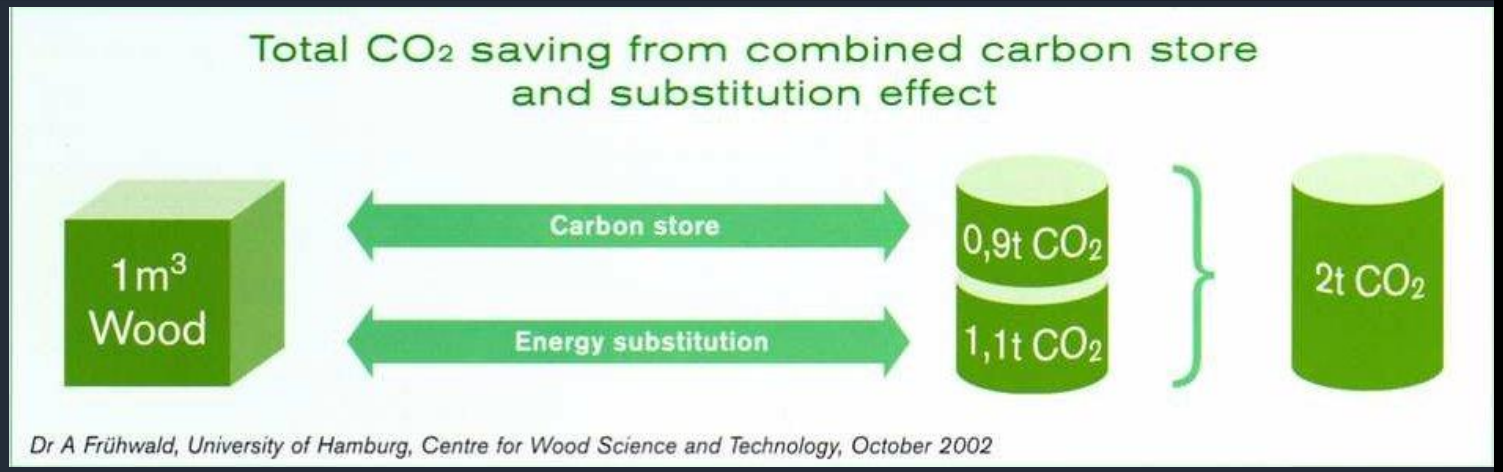
INTRODUCTION

SUSTAINABILITY: TACKLE CLIMATE CHANGE

Static and dinamic carbon sequestration

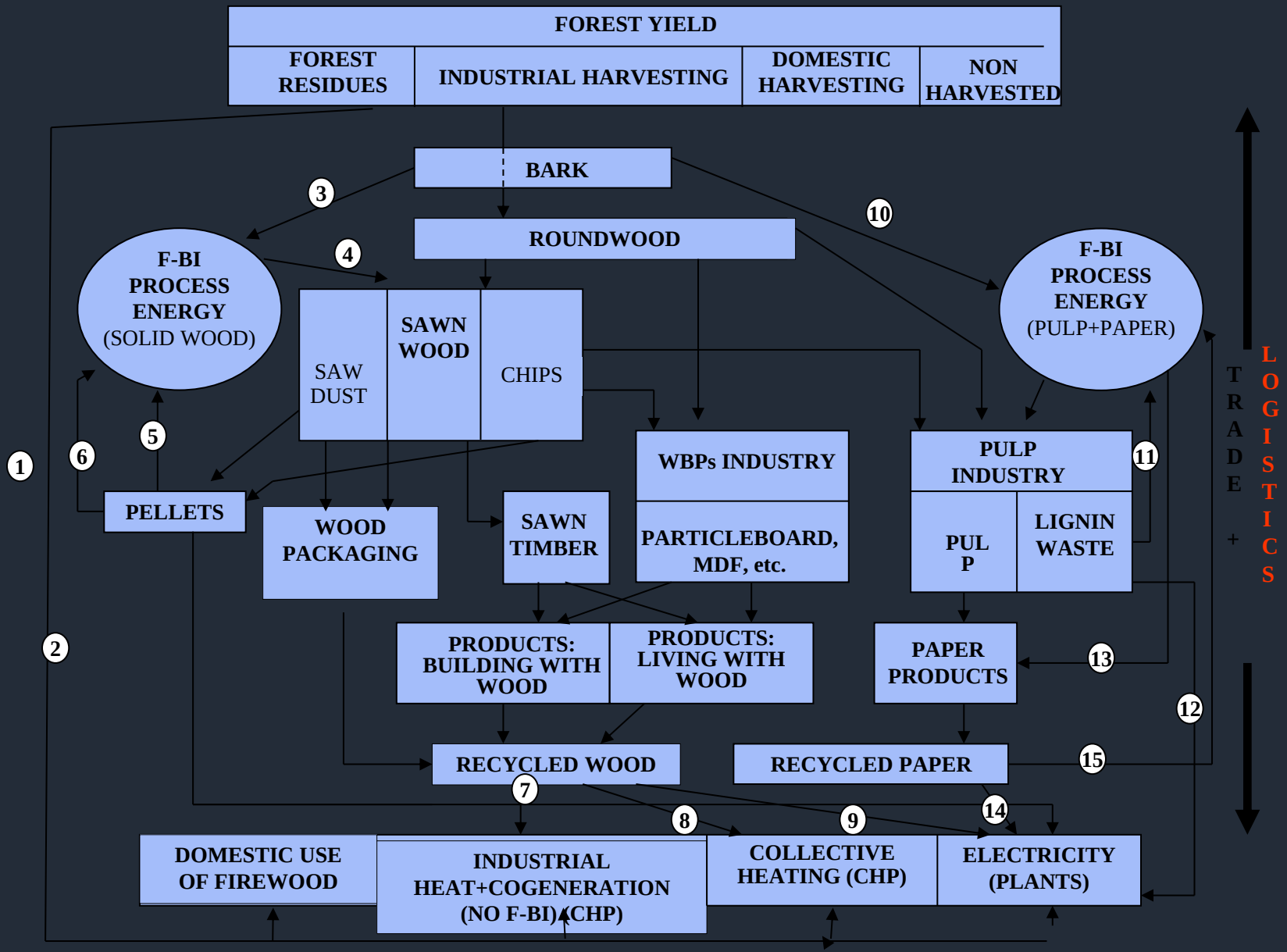
INTRODUCTION

SUSTAINABILITY: CASCADE USE OF FOREST BIOMASS



1713 – 2013: Hans Carl von Carlowitz : THE PRICIPLE OF FOREST SUSTAINABILITY

INTRODUCTION


FOREST YIELD
FOREST RESIDUES
INDUSTRIAL HARVESTING
DOMESTIC HARVESTING
NON HARVESTED
BARK
ROUNDWOOD
F-BI PROCESS ENERGY (SOLID WOOD)
F-BI PROCESS ENERGY (PULP+PAPER)
SAW DUST
SAWN WOOD
CHIPS
PELLETS
WOOD PACKAGING
SAWN TIMBER
WBPs INDUSTRY
PARTICLEBOARD, MDF, etc.
PULP INDUSTRY
PUL P
LIGNIN WASTE
PRODUCTS: BUILDING WITH WOOD
PRODUCTS: LIVING WITH WOOD
PAPER PRODUCTS
RECYCLED WOOD
RECYCLED PAPER
DOMESTIC USE OF FIREWOOD
INDUSTRIAL HEAT+COGENERATION (NO F-BI)(CHP)
COLLECTIVE HEATING (CHP)
ELECTRICITY (PLANTS)
TRADE + LOGISTICS
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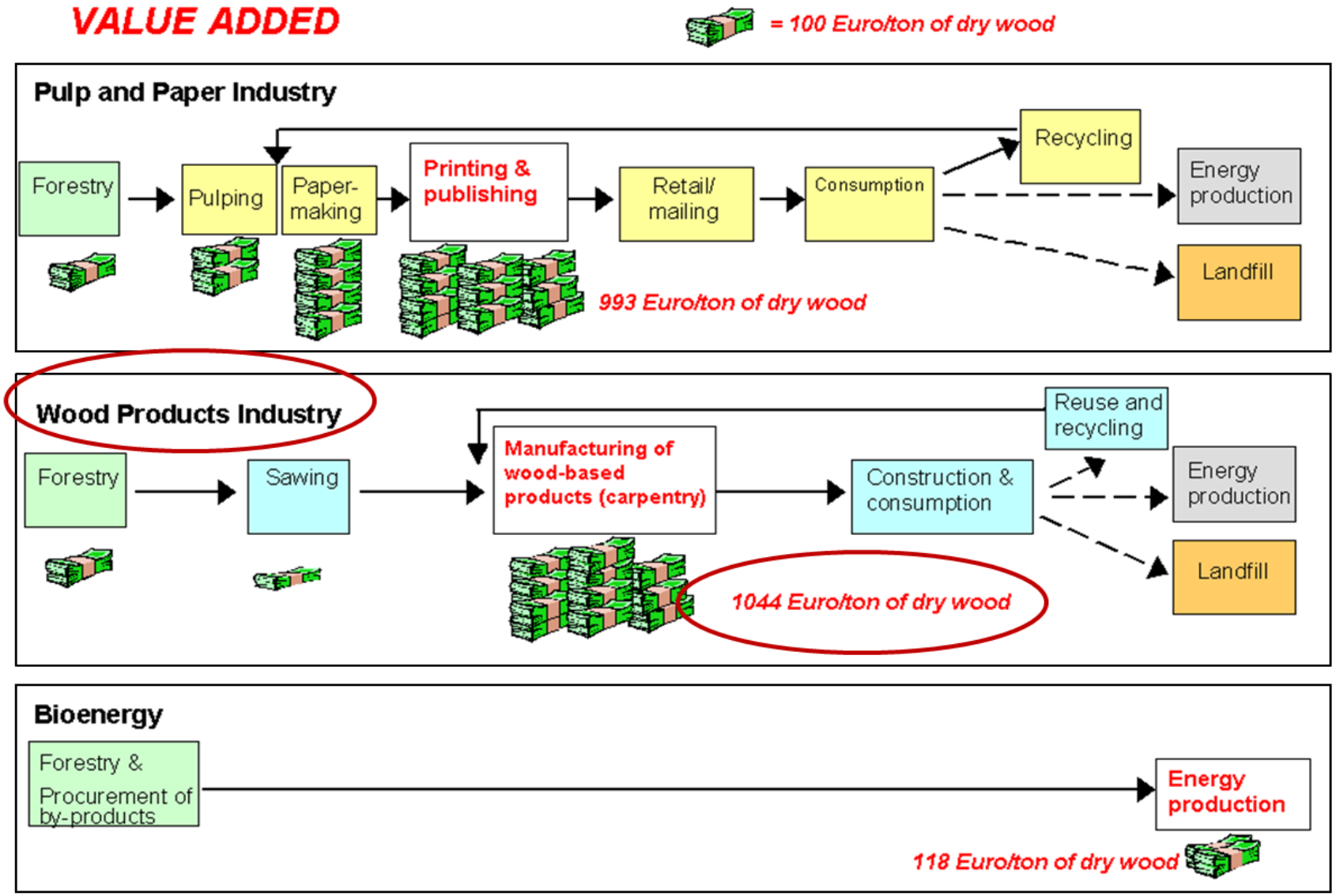
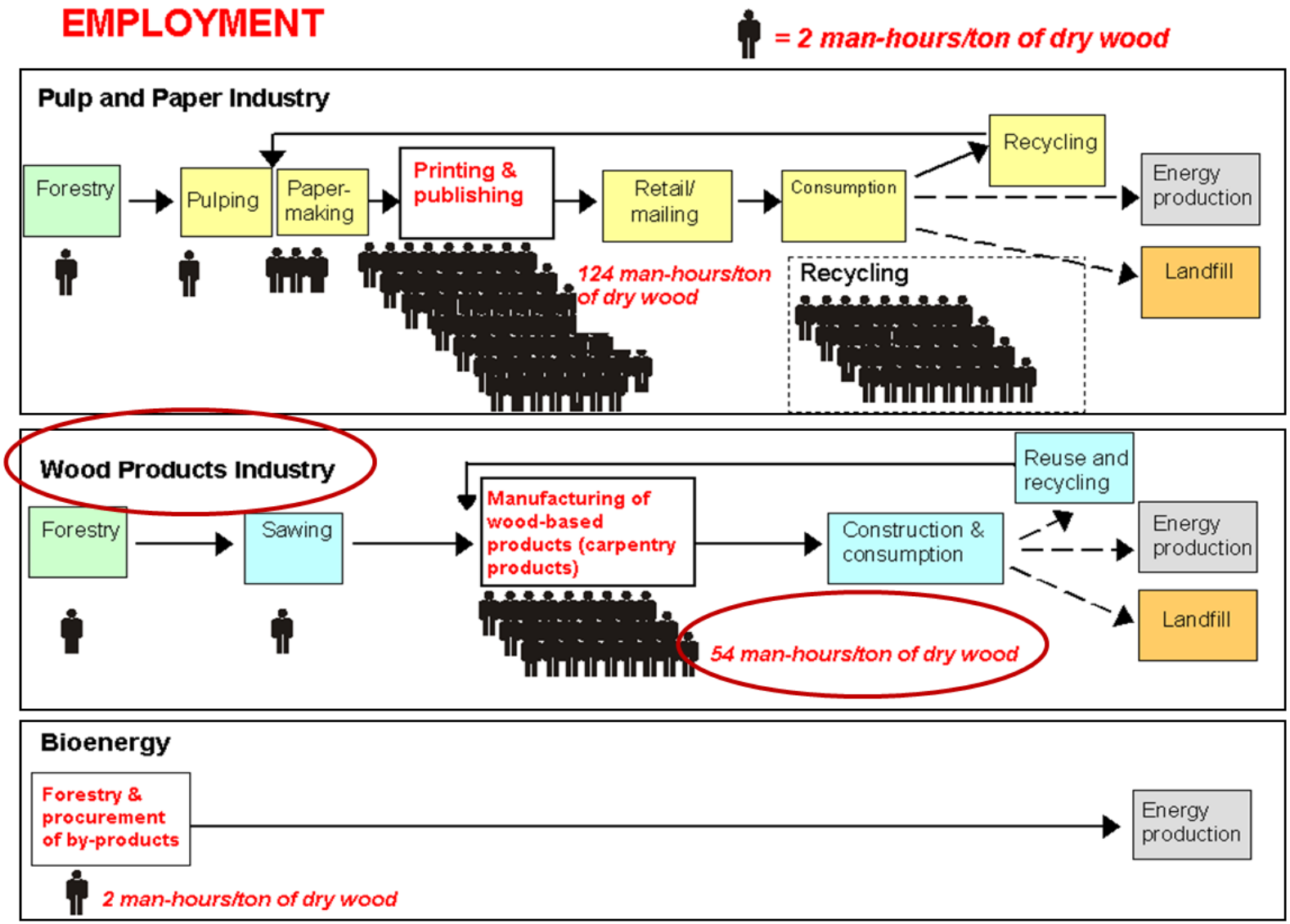
Comparing Economic Value Chains

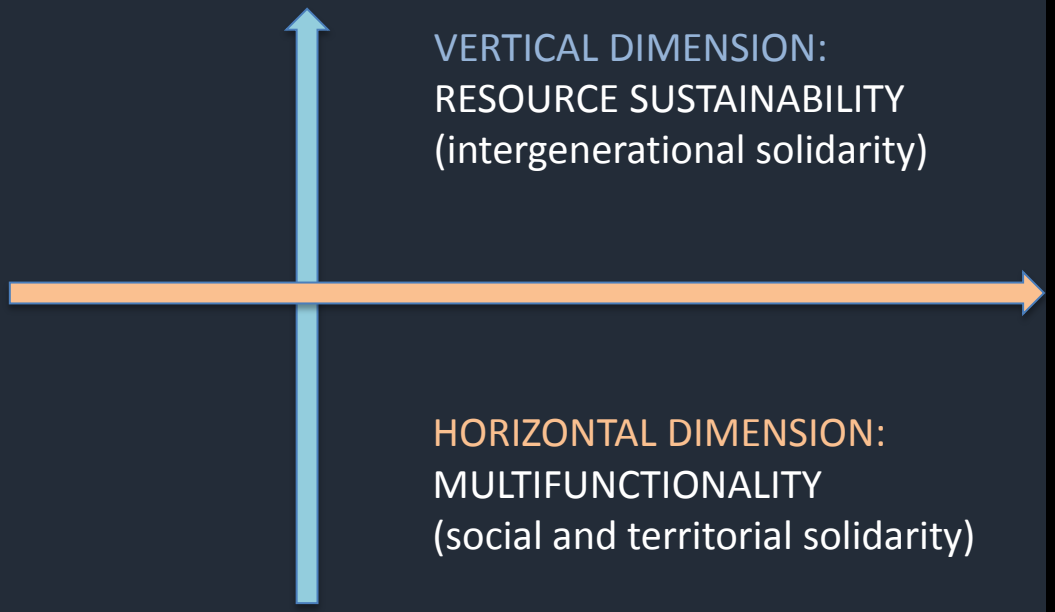


Comparing Social Value Chains



KEY SUSTAINABILITY CHALLENGES FOR FOREST-BASED BIOENERGY

SUSTAINABILITY
AS BASIS FOR A LOW CARBON AND KNOWLEDGE-DRIVEN BIOECONOMY
from Carlowitz to today



VERTICAL DIMENSION:
RESOURCE SUSTAINABILITY
(intergenerational solidarity)

HORIZONTAL DIMENSION:
MULTIFUNCTIONALITY
(social and territorial solidarity)

KEY SUSTAINABILITY CHALLENGES FOR FOREST-BASED BIOENERGY

1. RATIONALE USE OF FOREST RESSOURCES

2. ENERGY RECOVERY OF LIGNOCELLULOSIC WASTE:
   optimisation of contribution to mitigation of climate change

3. INTEGRAL VALORISATION PROJECTS AT LOCAL/SUBREGIONAL SCALE:
   carbon emmisions minimisation, economic optimisation and rural development

BIOENERGY
development in CV based on

huge potential of
BIOMASS SOURCES
in rural areas

FOREST-BASED BIOENERGY

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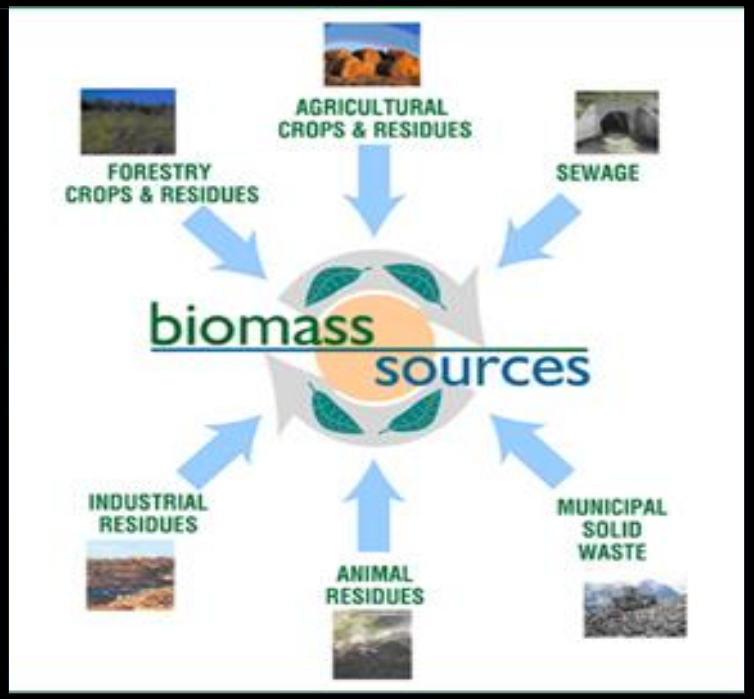

FOREST-BASED BIOENERGY

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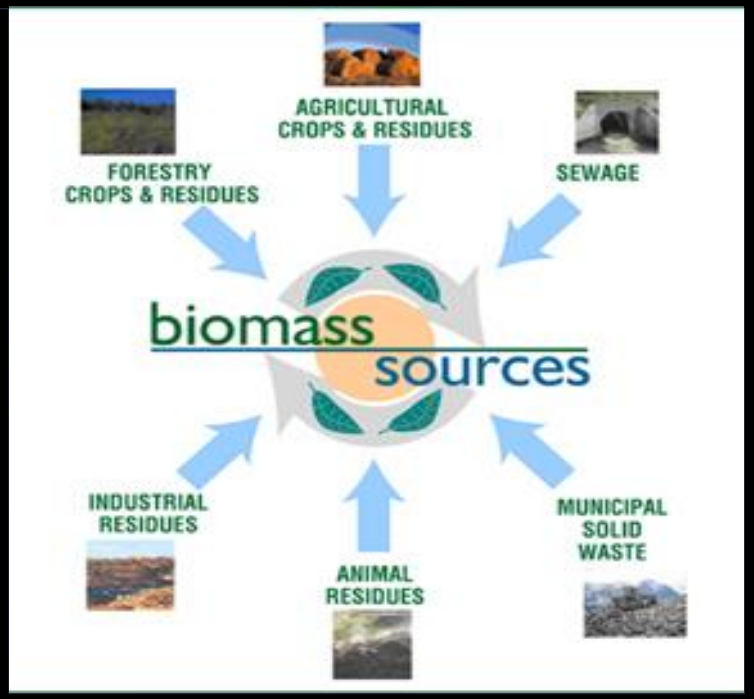

FOREST-BASED BIOENERGY

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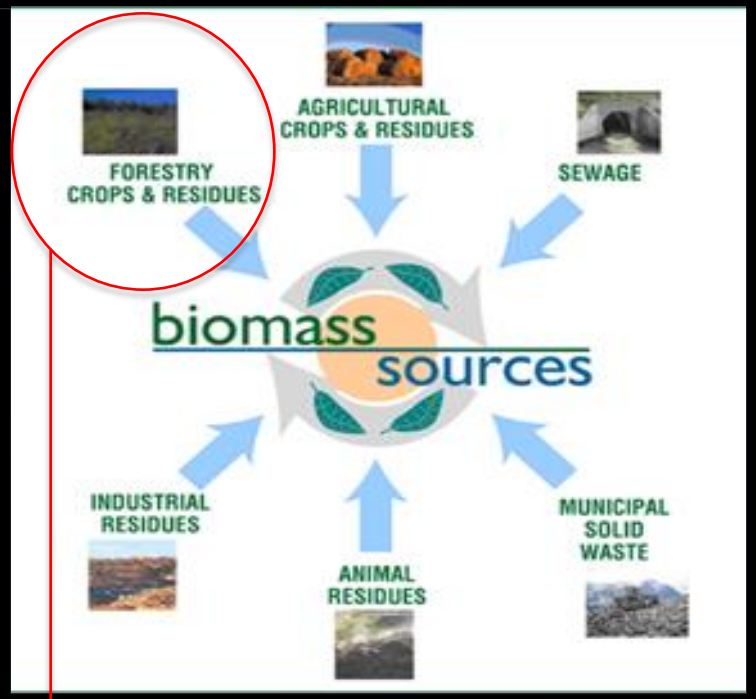

FOREST-BASED BIOMASS

- >50% forest land

BIOENERGY
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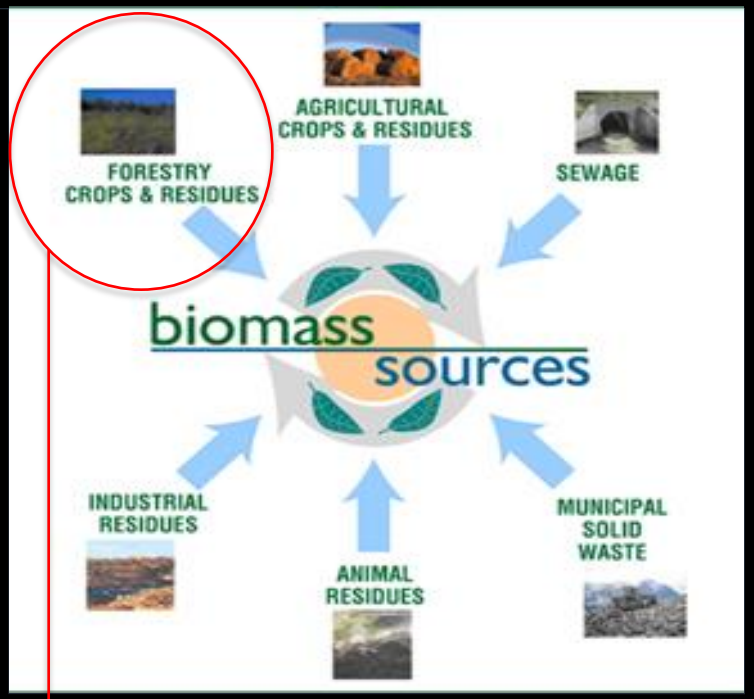

FOREST-BASED BIOMASS

- >50% forest land
- increasing forest area and stocking volume in large unmanaged forests

FOREST-BASED BIOENERGY

BIOENERGY
development in CV based on

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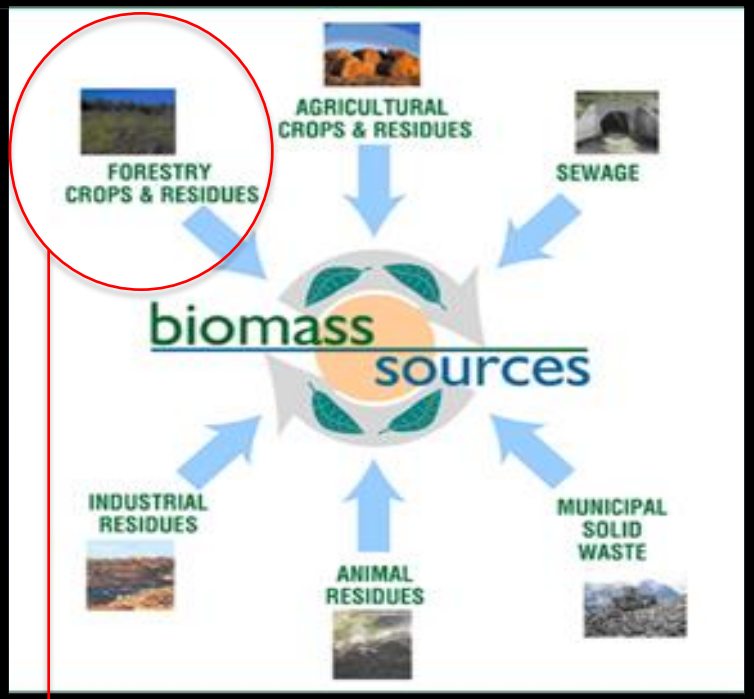

FOREST-BASED BIOMASS

- >50% forest land
- increasing forest area and stocking volume in large unmanaged forests
- fire prevention silviculture

FOREST-BASED BIOENERGY

BIOENERGY
development in CV based on

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BIOMASS SOURCES
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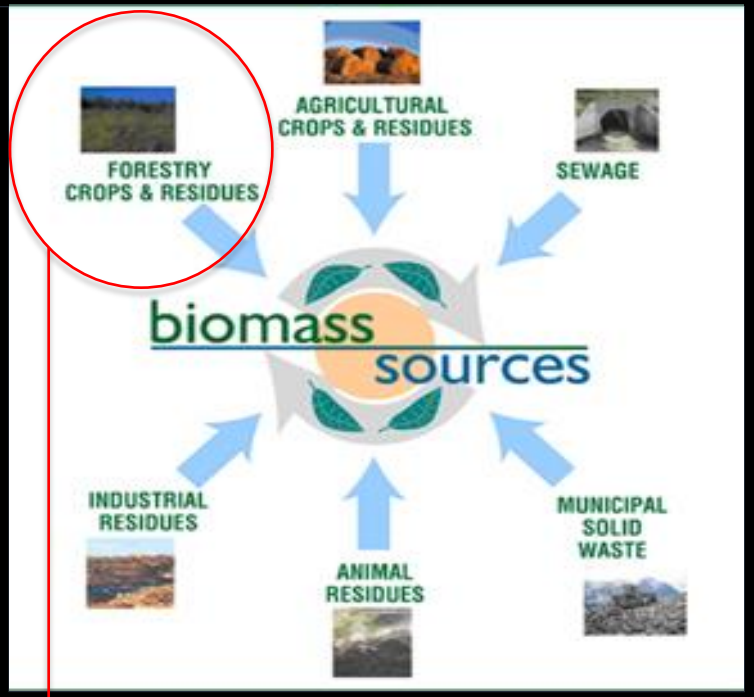

Tipo de biomasa	Procedencia	Humedad (base húmeda) en el momento de la corta.	Poder Calorífico Superior Humedad=0% MJ/kg (valores medios)	Poder Calorífico Inferior (PCI) Kcal / kg (valores medios)
P. pinaster (ramas)	Varias	35-50 (42.5)	21.1	2465.2597
P. pinaster (madera)	Varias	40-50 (45)	20.7	2280.1338
P. pinaster (corteza)	Varias	25-40 (32.5)	21.0	2979.6299
P. halepensis (ramas)	Zaragoza	30-45 (37.5)	20.8	2685.7503
P halepensis (madera)	Zaragoza	38-48 (43)	20.4	2343.5090
P halepensis (corteza)	Zaragoza	25-40 (32.5)	20.0	2818.5320
P. sylvestris (ramas corta)	Varias	35-50 (42.5)	21.1	2465.2597
P. pinea (árbol entero, claras)	Ciudad Real	40-48 (44)	20.2	2265.4013
P. nigra (ramas corta)	Varias	35-50 (42.5)	20.6	2396.6439
P. radiata (ramas corta)	Pais Vasco	38-50 (44)	20.5	2305.4968
E.globulus(ramas)	Asturias	50-55 (52.5)	20.2	1832.7511
E.globulus(madera)	Asturias	55-65 (60)	19.5	1384.1752
E.globulus(corteza)	Asturias	45-55 (50)	15.9	1446.8747
F silvatica (madera)	Varias	40	19.2	2325.804
Castanea sativa (madera)	Varias	40	19.8	2411.722
Populus sp. (ramas corta)	Varias	40-50 (45)	19.4	2109.4894
Q. pyrenaica(ramas sin hojas)	Soria	35-45 (40)	19.2	2325.804
Q. pyrenaica(rollo cc)	Soria	38-50 (44)	19.1	2118.3843
Q. petraea (madera)	Varias	40	19.3	2340.123
Q. ilex (hojas)	Varias	40	19.3	2340.123
Q. ilex (ramillas)	Varias	40	18.5	2225.565
Q. ilex (madera)	Varias	40	18.2	2182.605
Q. ilex (desbroce)	Varias	40	19.2	2325.803

FOREST-BASED BIOMASS

- >50% forest land
- increasing forest area and stocking volume in large unmanaged forests
- fire prevention silviculture
- high calorific power

FOREST-BASED BIOENERGY

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on REGIONAL CO-OPERATION

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on REGIONAL CO-OPERATION

UNIVERSITIES

RESEARCH CENTRES

FOREST OWNERS

SMEs

NGOs

PUBLIC ADMINISTRATIONS

etc.

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

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PLATAFORMA FORESTAL VALENCIANA
Gestión forestal sostenible

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PLATAFORMA FORESTAL VALENCIANA
Gestión forestal sostenible

FOREST SECTOR

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on REGIONAL CO-OPERATION

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PLATAFORMA FORESTAL VALENCIANA
Gestión forestal sostenible

FOREST SECTOR

WG BIOENERGY

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on EU CO-OPERATION

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on EU CO-OPERATION

Cost E9 “LCA of forestry and forests products” 2000-2005

Cost E31 "Management of Recovered Wood” 2004-2008

INTERREG IIIC PERSPECTIVE 2005-2008

LIFE+ BEST4VARIOUSE 2009-2012

LIFE+ FIRE PREVENTION & BIOENERGY 2010-2013

MED PROFORBIOMED 2011-2014

+ ERASMUS + LEONARDO

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on SUSTAINABILITY

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

development of forest-based bioenergy value chain at local level in Mediterranean rural areas based on SUSTAINABILITY

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

ENVIRONMENTAL BENEFITS

- Extraction of forest residual biomass
- Active fire prevention silviculture: reduction of bushfire risk
- Improved forest ecosystems, soil protection, water regime and biodiversity
- Natural regeneration and increased CO_2 fixation
- Production and use of bioenergy at local level
- Substitution of fossil energy sources: reduction of CO_2 emissions
- Active mitigation of climate change

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

DEVELOPMENT OF LOCAL ECONOMIES

- Valorization of non-used forest residues: from waste to product
- Forest companies: forestry planning and management
- Harvesting companies: optimization and technological development of harvesting and logistics processes
- Local investors for bioenergy industrial projects at small and medium scale
- Local bioenergy distribution: thermal, electrical or biofuels
- SRCs as complementary energy crops at marginal agricultural land
- Integrated industrial projects across the entire bioenergy value chain in rural areas at local level

SUSTAINABLE DEVELOPMENT OF THE FOREST-BASED BIOENERGY CHAIN

SOCIAL IMPACTS

- Direct employment: forest management, harvesting and logistic operations, energy conversion processes, energy distribution etc.
- Indirect employment in rural areas: services (2x1)
- Education and training in a future-oriented sector: specialised skills and knowledge transfer
- Active contribution to a KBBE in Mediterranean rural areas

FOREST-BASED BIOENERGY POTENTIAL

PATFOR (2013):

Forest (and agricultural) biomass potential: 1,2 Mt/y = 260.000 toe

5% of regional energy demand

750.000 CO_2 t/y reduction of emissions

Additional potential of lignocellulosic energy crops (SRC)

Direct+indirect employment in rural areas

FOREST-BASED BIOENERGY POTENTIAL
IN THE COMMUNITY OF VALENCIA

FOREST-BASED BIOENERGY POTENTIAL IN THE COMMUNITY OF VALENCIA

INDUSTRIAL/VALORIZATION PROJECTS

8-10 industrial CHP plants at small scale (2 MW, 20.000 t/y)

10 x 15 M Kweh/y = 150 Mio Kweh/y x 0,14€/KWeh = 21 Mio €/y

10 x 40 M KWth/y = 400 Mio KWth/y x 0,03€/KWth = 12 Mio €/y

10-15 district heatings (1 MW, 10.000 t/y)

10 x 40 M KWth/y = 400 Mio KWth/y x 0,03€/KWth = 12 Mio €/y

8-10 pellet plants (10.000 t/y)

10 x 10.000t/y pellets x 200 €/t = 20 Mio €/y

FOREST-BASED BIOENERGY POTENTIAL IN THE COMMUNITY OF VALENCIA

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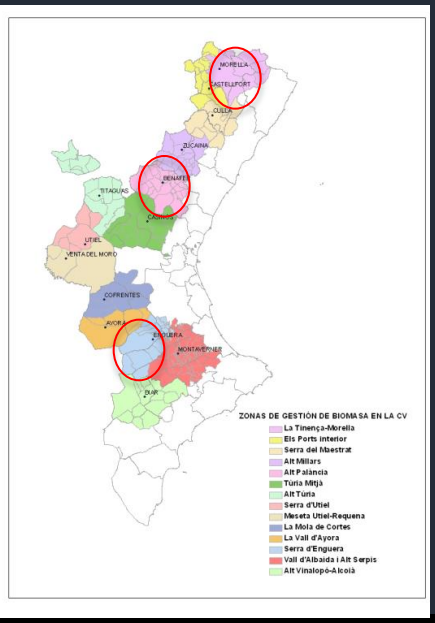
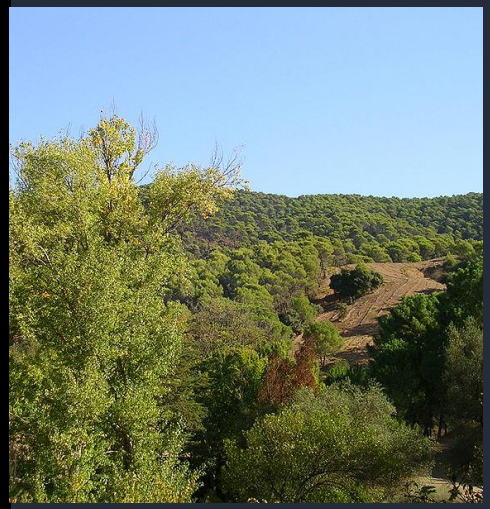


FOREST-BASED BIOENERGY POTENTIAL IN THE COMMUNITY OF VALENCIA

INTEGRAL FOREST-BASED BIOMASS MODEL



FBiomass

private
municipal
public

ABiomass

private

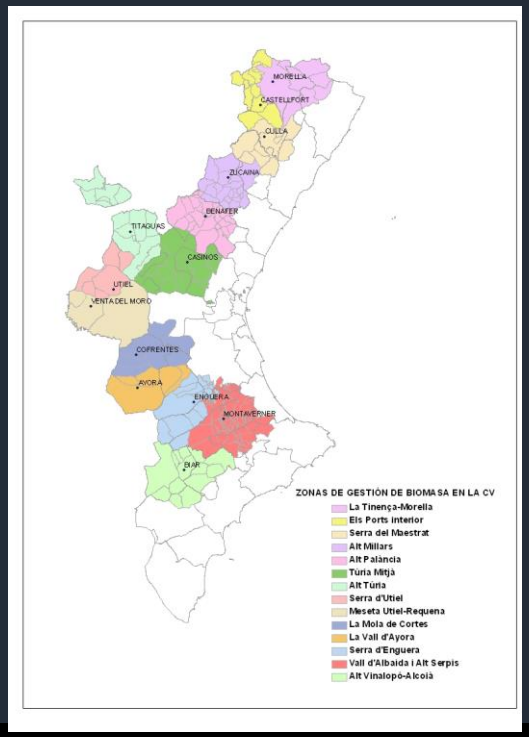
Energy crops

Private

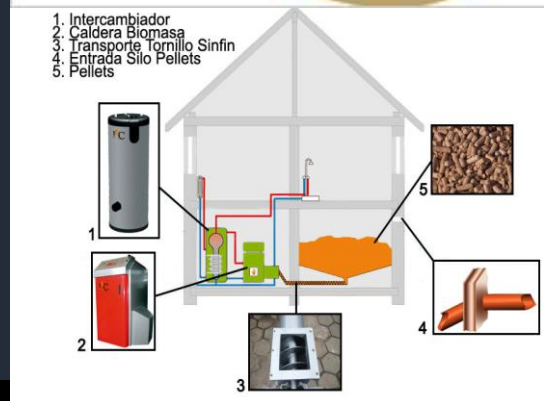
Urban and industrial waste biomass

municipial
private

Logística



Logística



Direct employment
(ex. integral project in ENGUERA)

17.000 ha public forests (Canal de Navarrés)
12.000 ha municipal forests (Municipality of Enguera)
9.000 ha municipal forests (Municipality of Moixent)
13.000 ha private forests
15.000 ha private agricultural land (olive and almond crops)
500 ha SRCs as energy crops
Approx. 30.000 t/y

Forest planning (inventory and management plans, harvesting annual plans)	2
Harvesting operations and in-situ chipping	16
Transport and logistics	6
CHP plant (2MW)	11
Pellet plant	9
TOTAL	44

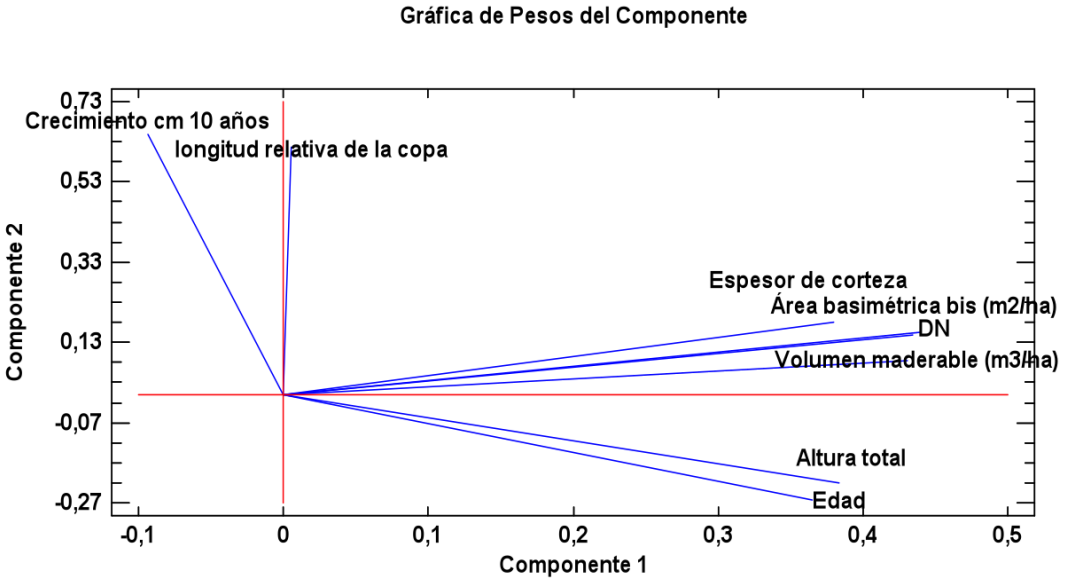
+ INDIRECT EMPLOYMENT (x1,8)

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

1. Biomass oriented forest management plans for sustained raw material supply

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

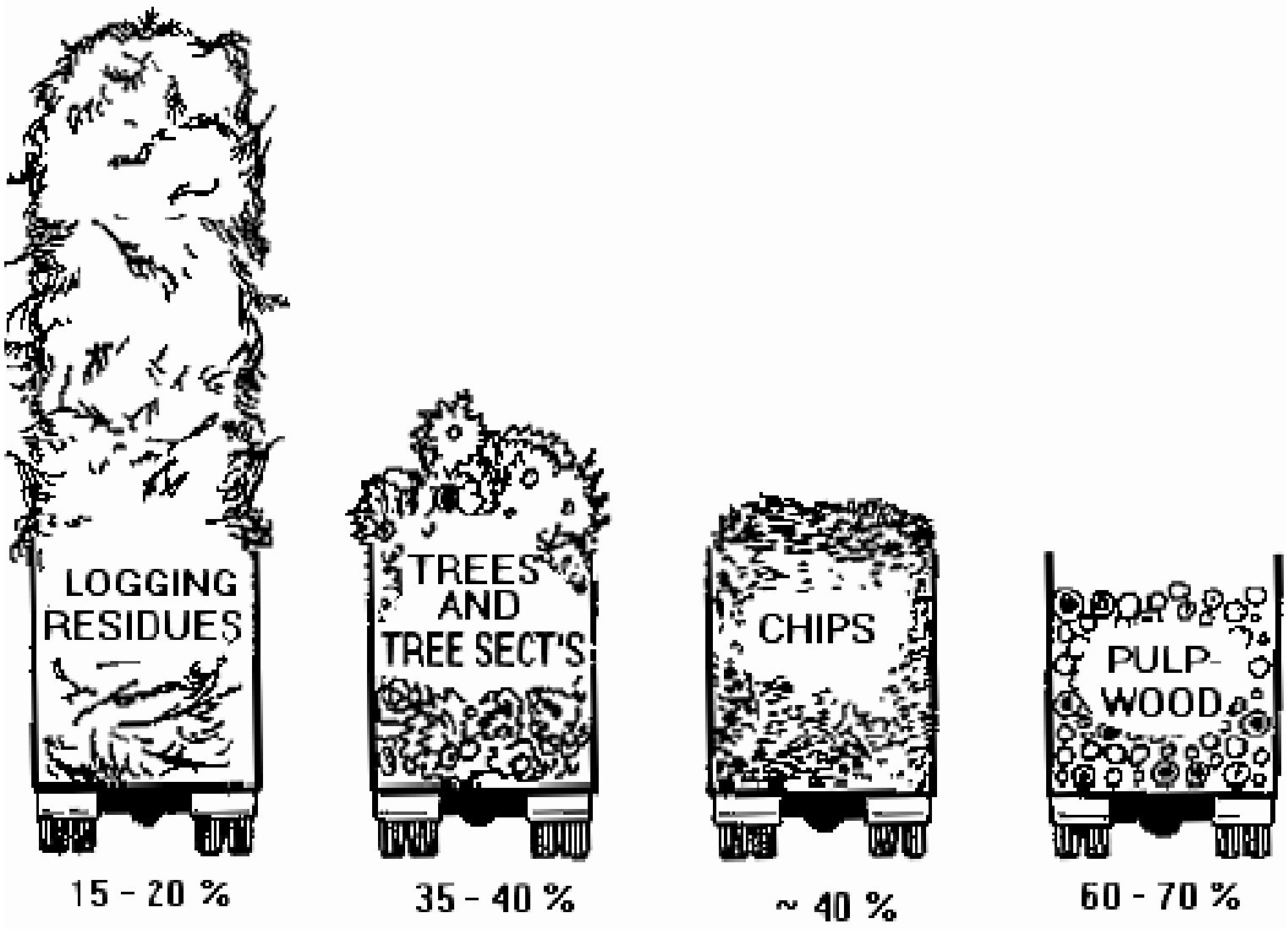


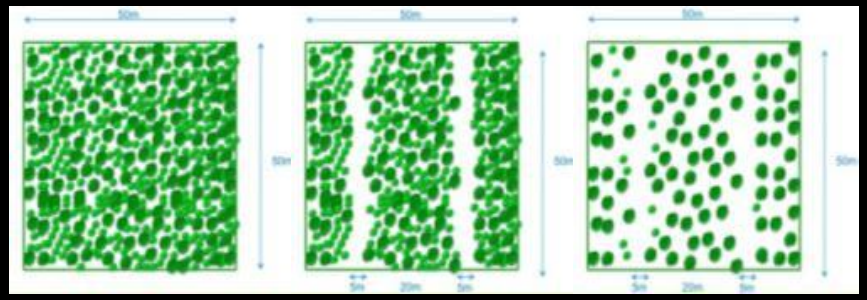
Bioenergy oriented approach for harvesting plans in pure stands of *Pinus halepensis* (LIFE BIOENERGY AND FIRE PREVENTION 2013)

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

1. Biomass oriented forest management plans for sustained raw material supply
2. Optimisation of harvesting and logistic costs

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS


LOGGING RESIDUES
15 - 20 %
TREES AND TREE SECT'S
35 - 40 %
CHIPS
~ 40 %
PULP-WOOD
60 - 70 %


50m
50m
50m
50m
50m
50m
5m
20m
5m
5m
20m
5m

HARVESTING SYSTEM	WORKING OPERATIONS	HOURLY COST (€/h)	EFFECTIVE WORKING TIME (h/t)	PRODUCTIVITY (t/h)	UNIT COST (€/t)
FULL-TREE HARVESTING	**FELLING** with chainsaw STIHL 045ii	15,00 €/h	0,732 h/t	1,366 t/h	10,98 €/t
	SKIDDING with forwarder VALMET 860	29,50 €/h	0,752 h/t	1,330 t/h	22,18 €/t
	CHIPPING with mobile chipper STARK SH4585	95,00 €/h	0,050 h/t	20 t/h	4,75 €/t
	TRANSPORT with multi-lift truck 25t (25 Km)				5,00 €/t
	TOTAL				**42,91 €/t**
INTEGRATED HARVESTING	**FELLING** with chainsaw STIHL 045ii	15,00 €/h	1,124 h/t	0,890 t/h	16,85 €/t
	DEBRANCHING with chainsaw STIHL 045ii	15,00 €/h	1,040 h/t	0,960 t/h	15,60 €/t
	SKIDDING with forwarder VALMET 860	29,50 €/h	0,976 h/t	1,025 t/h	28,79 €/t
	CHIPPING of crown material remained at forest	45,00 €/h	0,170 h/t	4,170 t/h	-
	CHIPPING with mobile chipper STARK SH4585	95,00 €/h	0,050 h/t	20 t/h	4,75 €/t
	TRANSPORT with multi-lift truck 25t (25 Km)				5,00 €/t
	TOTAL				**70,99 €/t**

Current tests with harvester for medium-aged reforested stands and with multitree harvester for young natural regenerated stands

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

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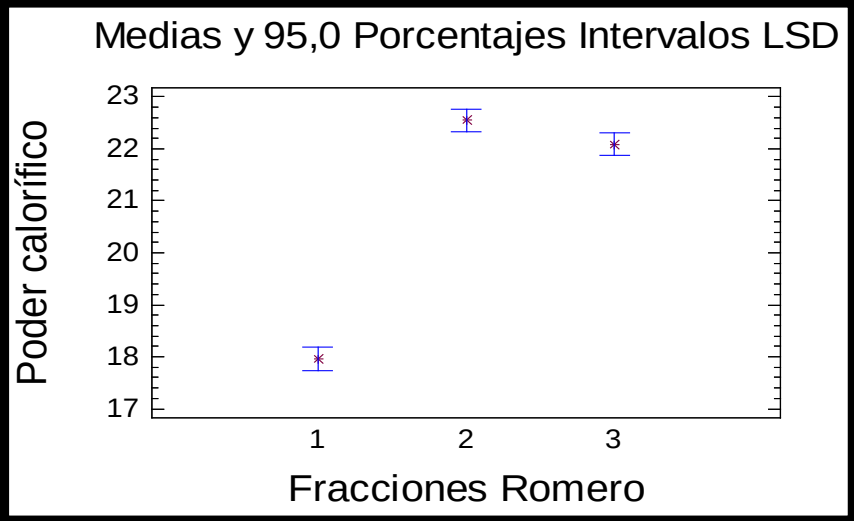
2. Optimisation of harvesting and logistic costs
3. Appropriated CHP technologies for Mediterranean biomass (combustion, gasification)

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

Fluid bed experimental gasificator (UPV – IIE)



Net calorific value of *Rosmarinus officinalis* in combustion tests (MJ/Kg)

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

1. Biomass oriented forest management plans for sustained raw material supply
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4. High qualitative biofuels (pellets, HTC, 2nd generation biofuels)

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

Propiedades del análisis	Unid.	Parámetros Técnicos	Cumplimiento de normas				
			Naranjo	Olivo	Almendro	Paulonia	Encina
Propiedades físicas							
Humedad	(%)	≤10	-	-	-	-	-
Densidad	Kg/m³	≥600[1]	√	√	√	x	√
Propiedades energéticas							
Cenizas	(%)	≤1,5[1]	x	x	√	√	x
PC	MJ/kg	16,3≥Q≤19[51]	x	√	√	√	√
Elementos químicos							
Nitrógeno (N)	%	≤0,5[1]	x	√	√	√	√
Azufre (S)	%	<0,03[1]	x	√	√	√	√
Arsénico (As)	mg/Kg	≤1,0[1]	√	√	√	√	√
Cromo (Cr)	mg/Kg	≤10,0[1]	√	√	√	√	√
Plomo (Pl)	mg/Kg	≤10,0[1]	√	√	√	√	√
Mercurio (Hg)	mg/Kg	≤0,1[1]	√	√	√	√	√
Níquel (Ni)	mg/Kg	≤10,0[1]	√	√	√	√	√
Zinc (Zn)	mg/Kg	≤10,0[1]	√	√	√	√	√

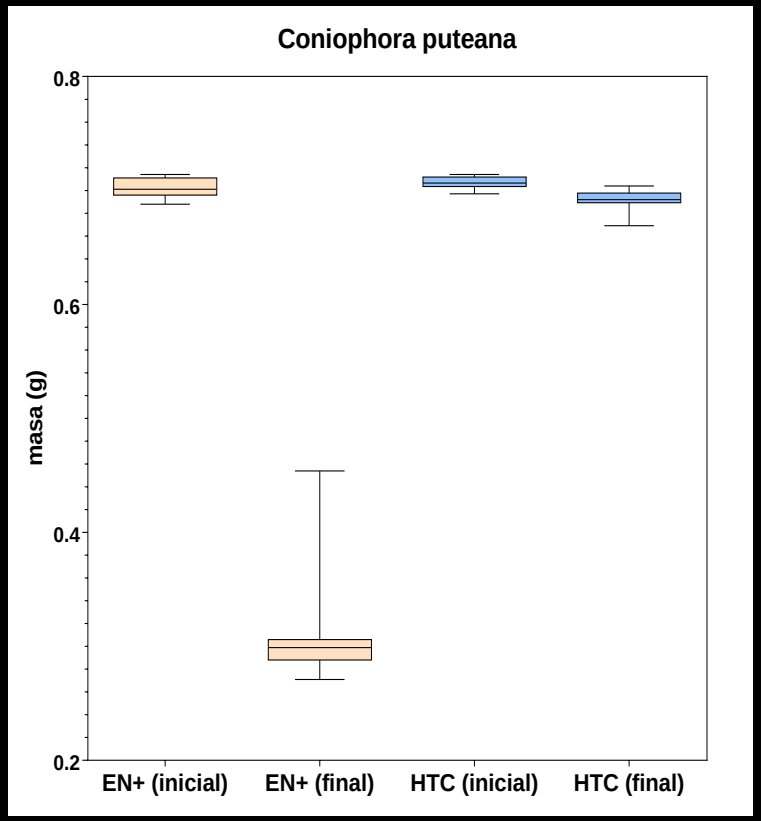
Pellet quality requirements (EN+) of different lignocellulosic raw materials

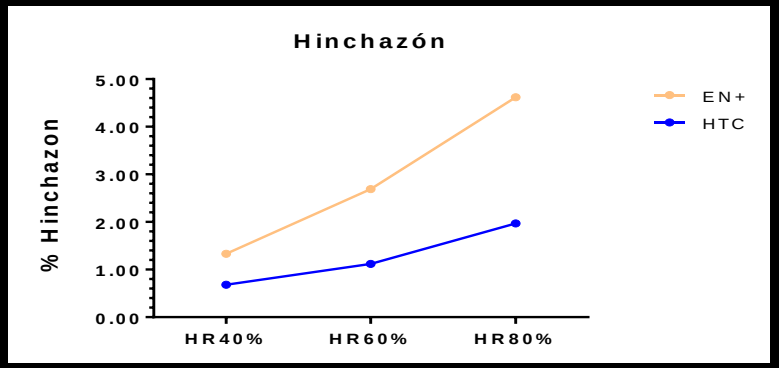
HTC tests with several forest waste material in INGELIA S.L (Náquera)

$$ICP = \frac{K1 * PCS + K2 * D + K3 * (1 - M)}{Hh * FR}$$

ICP	EN+	HTC
	0,289	0,545

Calorific Quality Index of HTC pellets





Durability of HTC pellets

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

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5. Energy contracting at local scale

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

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SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

Experimental plots of *Paulownia* SRC in Requena in several areas of the Community of Valencia

Zona Geográfica	Ecuación (MJ/árbol)	Ecuación (GJ/ha)
zona interior	= 4,8648 DAC2 - 15,5676 DAC + 8,7568	= 9,1966 DAC 2 - 29,429 DAC + 16,5538
zona costera 1	= 20,919 DAP2 - 410,11 DAP + 2.171,2	= 20,722 DAP 2 - 406,253 DAP + 2.150,8
zona costera 2	= 3,8919 DAP2 - 25,2973 DAP + 54,9729	= 3,8553 DAP 2 - 25,0595 DAP + 54,4562

Zona Geográfica	Pot. energético (MJ/árbol)	Pot. energético (GJ/ha)
zona interior	39,4	55,6
zona costera 1	191,2	189,4
zona costera 2	247,6	245,3

Source: Fernandez Puratich and Oliver Villanueva 2014; CO2DECIDE

INNOVATION CHALLENGES AND BUSINESS OPPORTUNITIES

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8. INVESTMENT

SUSTAINABLE DEVELOPMENT OF INTEGRAL FOREST-BASED BIOENERGY INDUSTRIAL PROJECTS

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Thank you!