ARAUCO
Sembremos Futuro

One Vision on Biorefinery in Chile

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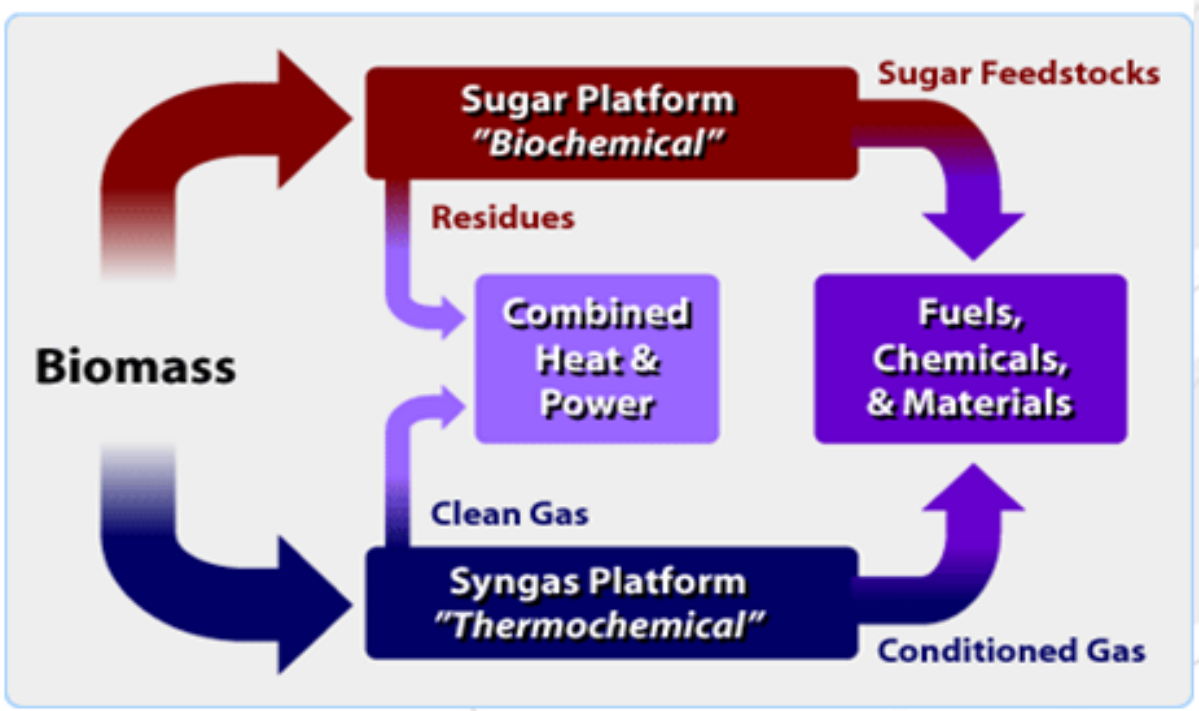
PUCON – CHILE
November 20th, 2012

THE CONCEPT

"A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass"

In the last decade, the biorefinery concept became popular. National Renewable Energy Laboratory (NREL)'s US, presented the concept on two platforms.



Source: www.nrel.gov/biomass

THE CONCEPT

The platforms are:

1. Biochemical: biological conversion process based on the fermentation of sugars extracted from biomass feedstocks.

2. Thermochemical: based on the gasification/pirolysis of biomass feedstocks and by-products from conversion processes.




MOTIVATIONS

Main motivations that increased the interest on this subject in pulp and paper industry:

1. Environmental pressure

2. Oil prices oscillation

3. Closure of pulp and paper mills north hemisphere, specially in North America.

1. ENVIRONMENTAL PRESSURE

IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Intergovernmental Panel on Climate Change (IPCC)

Photo: Ken Opprann

Albert Arnold (Al) Gore Jr.

The Nobel Peace Prize 2007 was awarded jointly to Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. *"for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change"*

Source: The Nobel Foundation

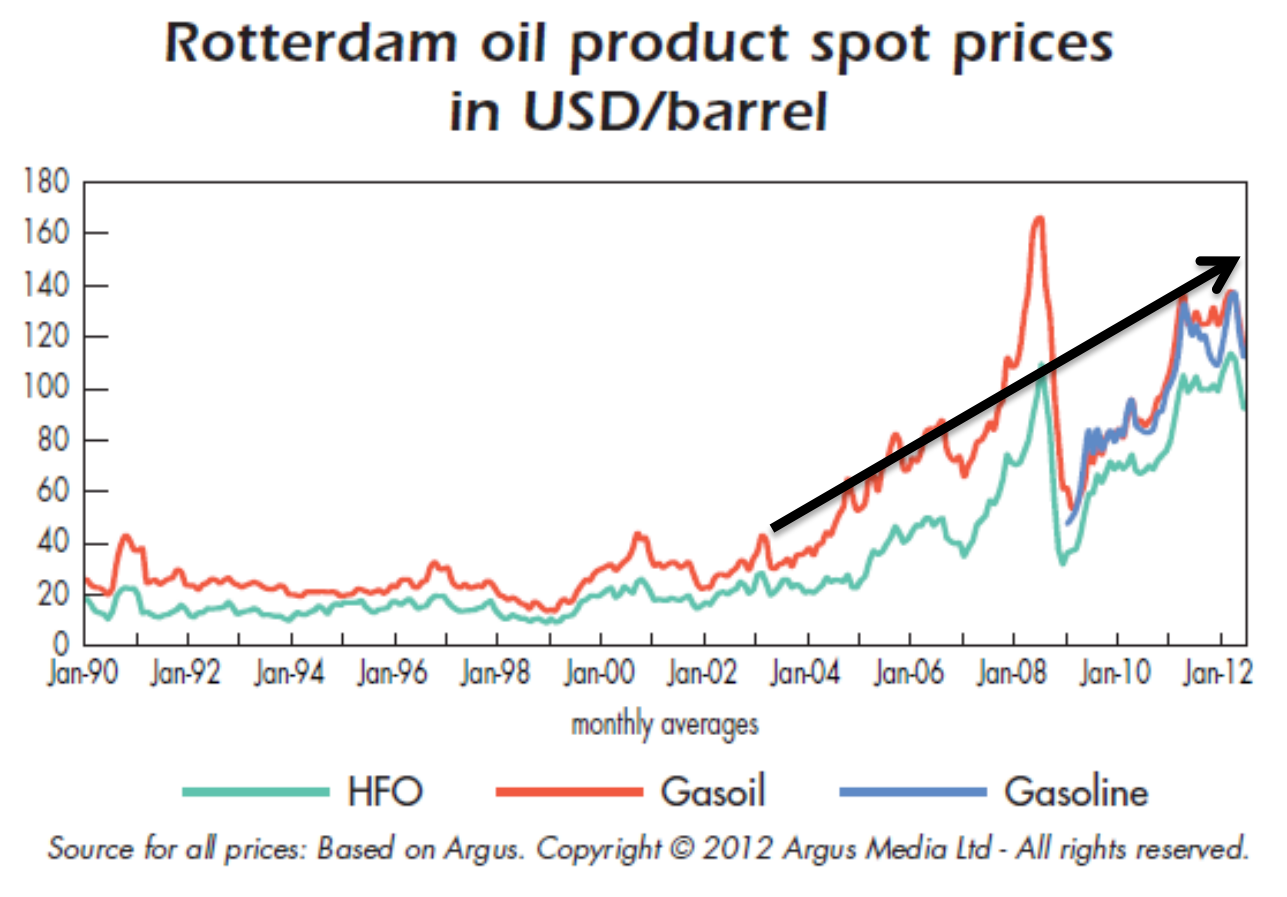
1. ENVIRONMENTAL PRESSURE

Ethanol → Environmentally friendly → Attention to Brazil and USA

	Ethanol	Gasoline
Sulfur content & sulfur compounds emission	☺	☹ $$
CO_2 , CO, VOC and fine particles	☺	☹
NOx	😐	😐
Volatility	☺ / 😐 ☹	😐
Toxicity of fuel & combustion products	☺	☹ $$
Life-cycle Greenhouse impact	☺	☹ $$
Renewability	☺	☹
Biodegradability in soil & water	☺	☹ $$

Source: World Food Security, Planted Forests and Bioenergy, BRACELPA, June 2008

2. OIL PRICE OSCILATIONS



HFO: Heavy Fuel Oil for Industry

3. PULP AND PAPER MILLS CLOSED IN NORTH AMERICA

Country	Company	Grade	Capacity (tons/year)	Shutdown Year	UFS NA	Pulp	CFS	Paper board	Newsprint
Canada	Abitibi-Consolidated	Newsprint	60,000		0	0		0	60,000
Canada	Abitibi-Consolidated Inc.	Newsprint	194,000	2005	0	0		0	194,000
Canada	Abitibi-Consolidated, Inc.	Newsprint	147,600	2005	0	0		0	147,600
Canada	Abitibi-Consolidated	Newsprint	441,000	2004	0	0	0	0	441,000
Canada	Bowater Inc.	Uncoated Groundwood	100,000	2003	0	0	100,000	0	
Canada	Cascades	Pulp	138,000	2004		138,000			
Canada	Cascades	Uncoated Freesheet	8,000	2005	8,000	0	0	0	
Canada	Cascades	Coated and Specialty Papers	52,200	2005	0	0	52,200	0	
Canada	Cascades	Coated	30,000	2005	0	0	30,000	0	
Canada	Domtar	Bleached Softwood Pulp	347,000	2005	0	347,000	0	0	
Canada	Domtar	Coated and Uncoated Freesheet	232,000	2006	114,240	0	117,810	0	
Canada	Domtar	Coated Freesheet	120,000	2006	0	0	120,000	0	
Canada	Domtar, Inc.	Uncoated Freesheet	50,000	2002	0	0	0	50,000	
Canada	Domtar, Inc.	Uncoated Freesheet	45,000	2004	0	0	0	45,000	
Canada	Minas Basin P&P	Linerboard	35,000	2002	0	0	0	35,000	
Canada	Neenah Paper	Bleached HW Kraft	125,000	2005	0	125,000	0	0	
Canada	New Skeena	Bleached SW Kraft	380,000	2001	0	380,000	0	0	
Canada	Norampac	Kraft Linerboard	150,000	2005	0	0	0		150,000
Canada	Norske Canada	Newsprint	154,000	2005					154,000
Canada	Norske Canada	Bleached SW Kraft	150,000	2001	0	150,000	0	0	
Canada	Parsons and Whittemore	Pulp	287,000	2004		287,000			
Canada	Port Alice Pulp Company	Pulp	176,000	2004		176,000			
Canada	Smurfit-Stone	Linerboard	258,000	2005	0	0	0	258,000	
Canada	Smurfit-Stone	Medium	223,000	2005	0	0	0	223,000	
Canada	Smurfit-Stone	Medium	243,000	2005	0	0	0	243,000	
Canada	Smurfit-Stone	Linerboard	235,000	2005	0	0	0	235,000	
Canada	Stora Enso NA	Sulfite Pulp	42,000	2004	0	42,000	0	0	
Canada	Tembec	Newsprint	83,000	2004					83,000
Canada	Tembec	Specialty Papers	77,000	2005					
Canada	Tembec	Hi-Brite Mechanical	68,000	2005	0	68,000	0	0	
Canada	UPM NA	Bleached Kraft	200,000	2005	0	200,000	0	0	
Canada	West Fraser Timber	Softwood Kraft Pulp	70,000	2006	0	70,000	0	0	
Canada	Weyerhaeuser	Uncoated Freesheet	280,000	2005	280,000	0	0	0	
Canada	Weyerhaeuser	Uncoated Freesheet	155,000	2005	150,000	0	0	0	
Canada	Weyerhaeuser Co	Corrugating Medium	100,000	2002	0	0	0	100,000	
			5,455,800		**552,240**	**1,983,000**	**420,010**	**1,189,000**	**1,229,600**

USA	Groveton Paper	Semichemical Medium Board	150,000	2006	0	0	0	0
USA	International Paper	Linerboard	100,000	2002	0	0	0	100,000
USA	International Paper	Uncoated Woodfree	180,000	2005	0	0	0	180,000
USA	International Paper	Uncoated Freesheet	142,000	2005	0	0	0	142,000
USA	International Paper	Corrugated Medium	100,000	2005	0	0	0	100,000

USA	Glatfelter	Uncoated Freesheet	4,500	2003	0	0	0	4,500
USA	Great Northern	Uncoated Groundwood	88,000	2002	0	0	88,000	0
USA	Groveton Paper	Semichemical Medium Board	150,000	2006	0	0	0	0
USA	International Paper	Linerboard	100,000	2002	0	0	0	100,000
USA	International Paper	Uncoated Woodfree	180,000	2005	0	0	0	180,000
USA	International Paper	Uncoated Freesheet	142,000	2005	0	0	0	142,000
USA	International Paper	Corrugated Medium	100,000	2005	0	0	0	100,000

USA	Rock-Tenn Co	Pasted Chipboard	106,000	2004	0	0	0	106,000
USA	SAPPI	Bleached Kraft Pulp	122,400	2005	0	122,400	0	0
USA	SAPPI	Coated Woodfree	105,000	2005	0	0	105,000	0
USA	SAPPI	Coated Freesheet	85,000	2003	0	0	85,000	0
USA	Simkins Industries	Recycled Boxboard	25,000	2002	0	0	0	25,000

Paper board	Newsprint
0	
0	150,000
21,600	
63,000	
100,000	
70,000	
87,000	
80,000	
72,000	
28,000	
56,000	
45,000	
14,000	
30,000	
420,000	
34,000	
0	
13,000	
43,000	
0	
0	
65,000	
0	
40,000	
4,500	
0	
0	

Production Capacity Between 2000-2006 Decreased in 14 mill ton

	Mills Closed	Capacity [ton/year]
USA	85	9.237.720
Canada	35	5.455.800

Source: Phillips R., 2006

NEW PULP MILLS TO START UP IN SOUTH AMERICA

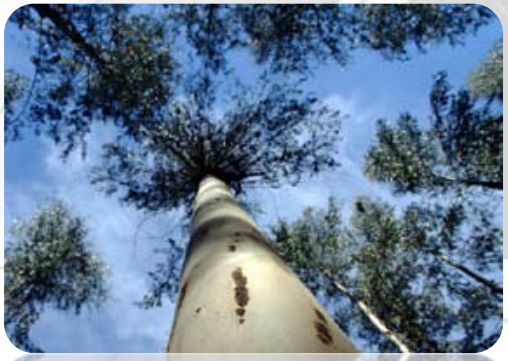
New Market Pulp Capacity in the coming years **(South America)**

COMPANY	LOCATION	CAPACITY, MILL TON	TIME
EL DORADO	TRES LAGOAS	1,5	2012
STORA ENSO/ARAUCO	COLONIA	1,5	2013
SUZANO	MARANHAO	1,5	2013
FIBRIA	TRES LAGOAS	1,5	2014
CMPC	GUAIBA	1,3	2014
SUZANO	PIAUI	1,5	2016
VERACEL	EUNOPÓLIS	1,5	N/A
CENIBRA	BELLO ORIENTE	0,8	N/A
KLABIN	PARANA	1,5	N/A
FIBRIA	ESPIRITO SANTO	1,3	N/A
SUZANO	BRAZIL	1,5	N/A
PORTUCEL	BRAZIL/URUGUAY	1,5	N/A

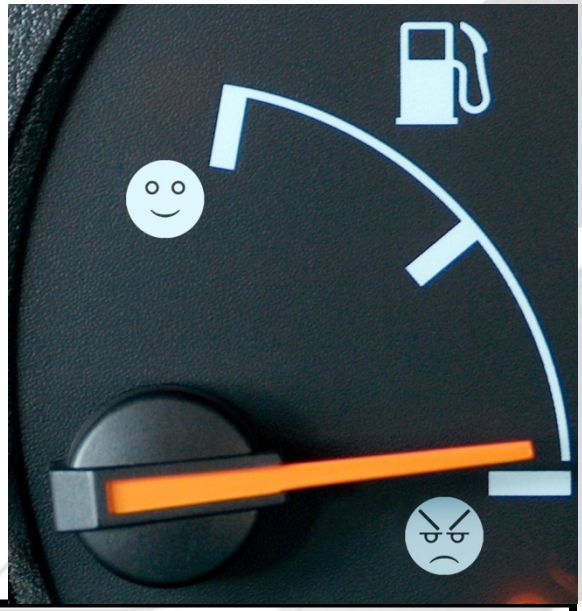
Source: RISI 2011

- **Mega Mills**
- **State of art technology**
- **High growth rate *Eucalyptus* plantations**

Increasing offer of market pulp about 10,3 mill ADt/year in the coming years

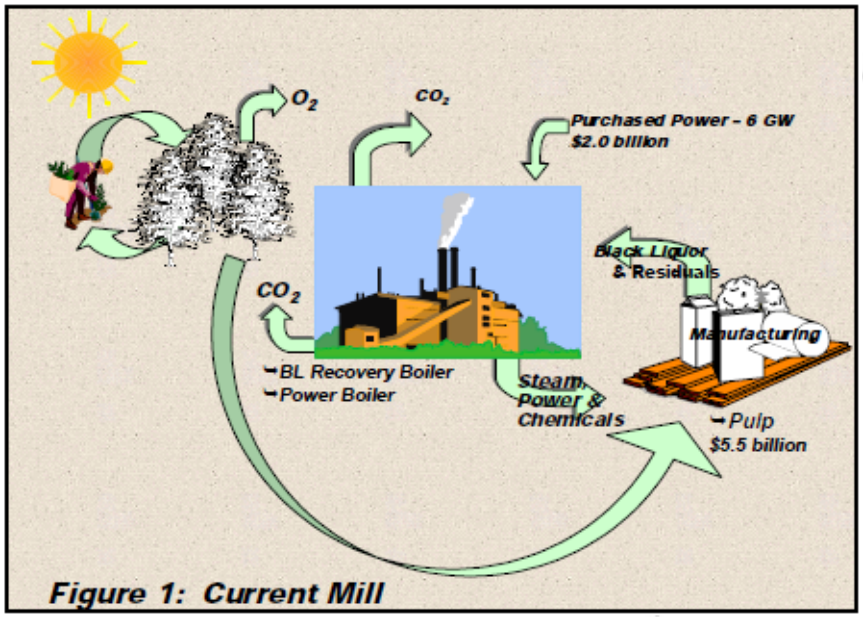


- **There will be space for low cost/high quality producers…**

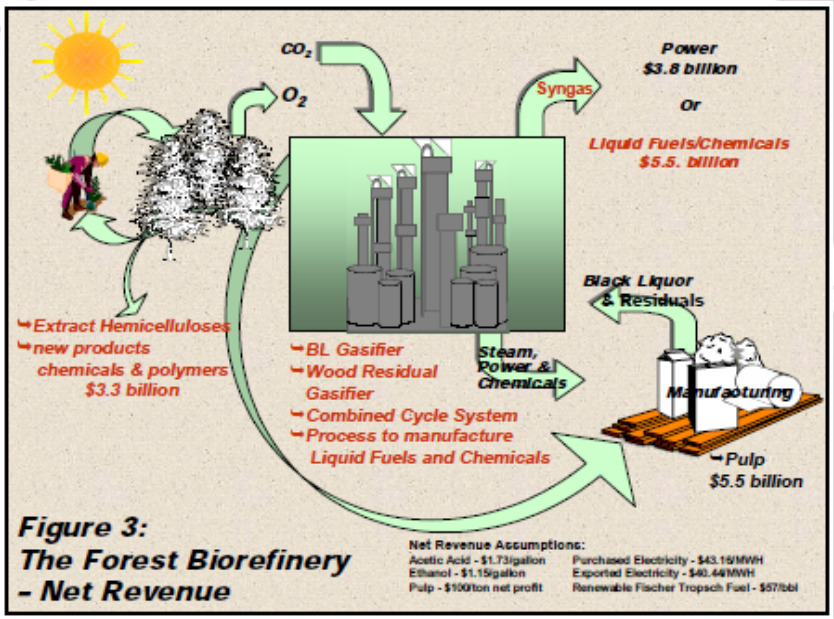


Clear need for alternatives

INTEGRATED FOREST PRODUCTS BIOREFINERY



Traditional products of a pulping mills
Not integrated



Manufacture bio-products after the pulp digester:

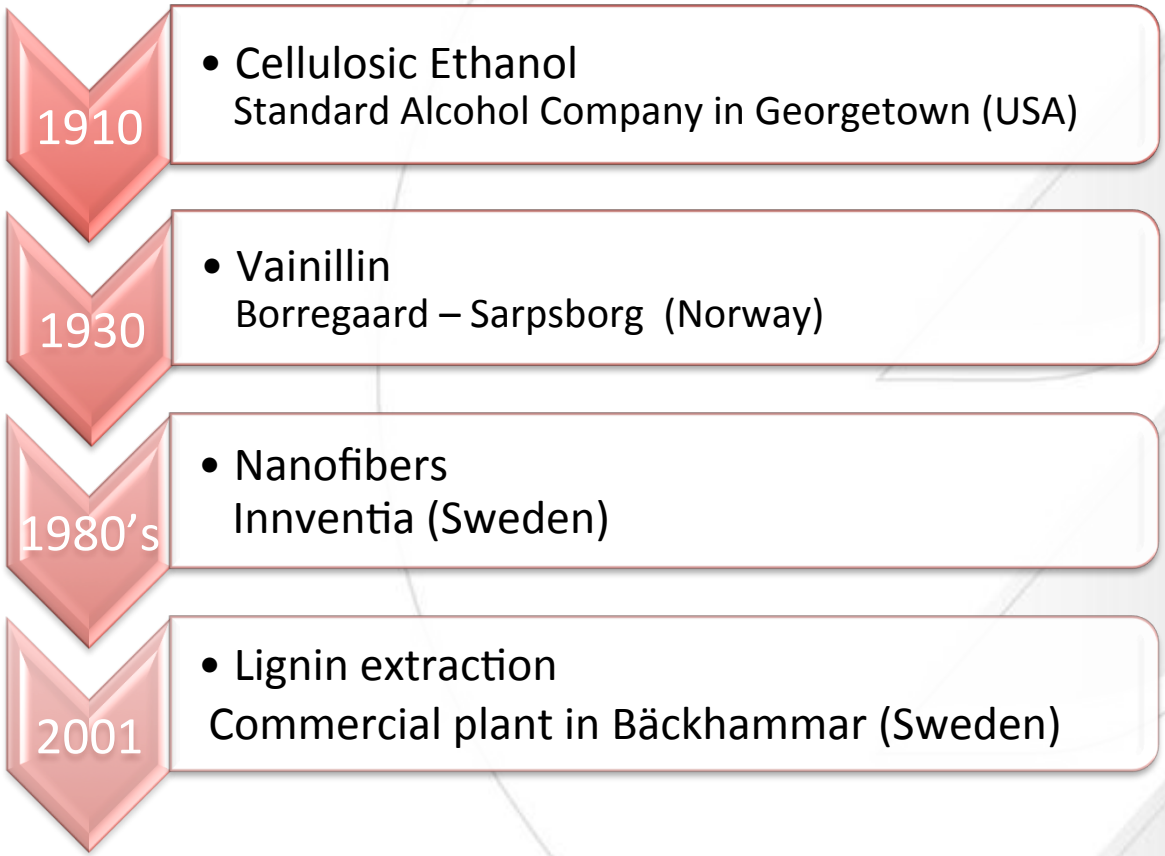
- liquid fuels
- power
- chemicals
- other high-value materials

↑140 %

Source: Closset G., Raymond D & Thorp B., June 2005

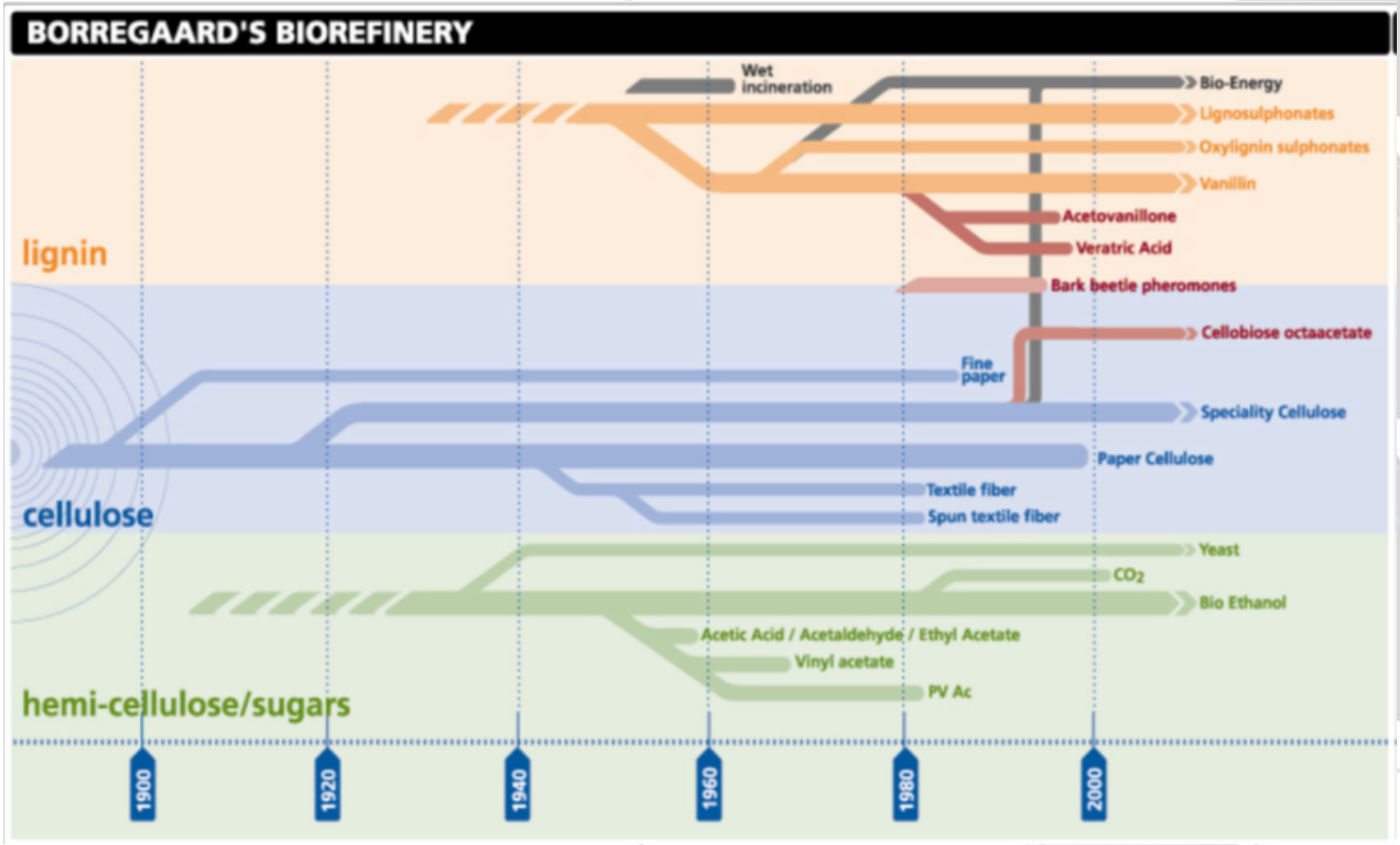
STATUS

The concept is new, but the ideas behind the technologies have been researched for long time:



STATUS

What we have learnt from Borregaard experience:



Source: Neumann, 2007

THE TRANSITION

Biofuels investment started few years ago and now they are present in many countries

Pilot/Demo

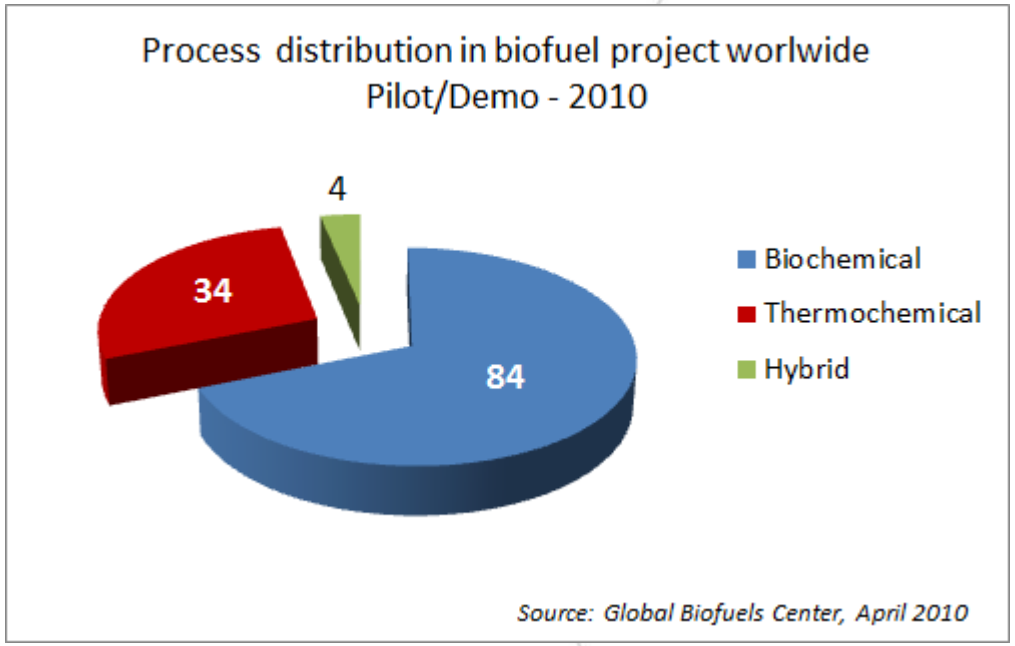
Commercial

- Postpone/Canceled
- Planned
- Opperational

Source: Bacovsky D., 2012

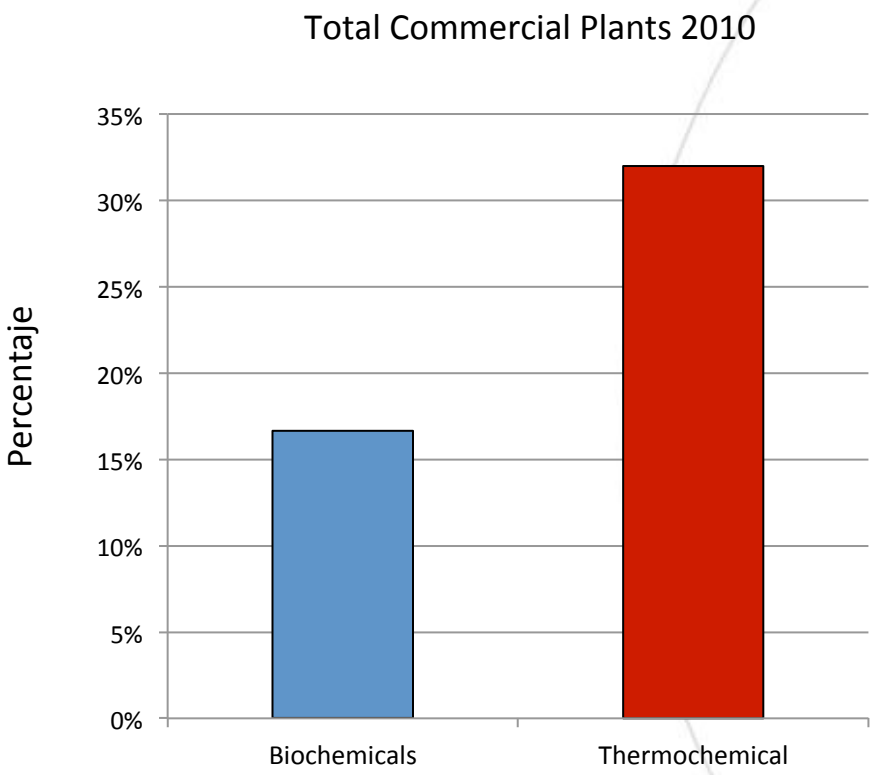
THE TRANSITION

Converting to numbers:



THE TRANSITION

Converting to numbers :



Source: Global Biofuels Center, April 2010

DRIVERS TO BE CONSIDERED

1. Regulations to use renewable energy and biofuels

2. Incentives to use renewable energy and biofuels

3. Competitiveness with others energy sources

4. Pre-existence industry

1. REGULATIONS

	REGULATORY POLICIE				FISCAL INCENTIVES				PUBLIC FINANCING	
	Feed-in tariff	Electric utility quota obligation	Biofuels obligation/mandate	Heat obligation/mandate	Capital subsidy grant	Investment or production tax credits	Reductions in sales, energy, CO_2 or Other taxes	Energy production payment	Public investment or grants	Public competitive bidding
ARGENTINA	●		●		●	●	●	●	●	●
AUSTRALIA					●				●	
AUSTRIA	●		●		●	●			●	
BRAZIL			●				●		●	●
CANADA			●		●	●	●		●	●
CHILE										
GERMANY	●									
INDIA			●	●	●	●	●		●	
NORWAY			●		●		●		●	
PERU	●		●			●	●	●		●
SPAIN	●		●	●		●	●		●	
SWEDEN		●	●	●	●	●	●	●		
U STATES			●		●	●	●	●	●	●

Source: Taxes and incentives for renewable energy KPMG INTERNATIONAL, June 2012

1. REGULATIONS

Directive 2003/30/EC of the European Parliament and of the Council of 8 May **2003 on the promotion of the use of biofuels or other renewable fuels for transport.**

"**An EU Strategy for Biofuels**" [COM(2006) 34 final - Official Journal C 67 of 18 March 2006].

Directive 2009/28/EC of the European Parliament and of the Council of 23 April **2009 on the promotion of the use of energy from renewable sources**.

The Energy Policy Act of 2005 (EPAct 2005, P.L. 110-58), established the first-ever Renewable Fuels Standard (RFS) in federal law, requiring **increasing volumes of ethanol and biodiesel to be blended with the U.S. fuel supply between 2006 and 2012.**

(…)corn-based ethanol (conventional biofuel) is essentially capped at **15 billion gallons by 2015, while 21 of the 36 billion gallons in 2022 must be derived from advanced biofuel such as cellulosic** and non-corn-based ethanol.

2. INCENTIVES

2. Incentives in Use energy renewable and biofuels

Special Depreciation Allowance for Cellulosic Biomass Ethanol Plant Property

Section 209 of the Tax Relief and Health Care Act of 2006 (P.L. 109-432) is administered by the Internal Revenue Service (IRS). **It allows a taxpayer to take a depreciation deduction of 50% of the adjusted basis of a new cellulosic ethanol plant in the year it is put in service**.

2. INCENTIVES

Department of Energy
FY 2012 Congressional Budget Request

Biomass and Biorefinery Systems RD&D
Funding Profile by Subprogram

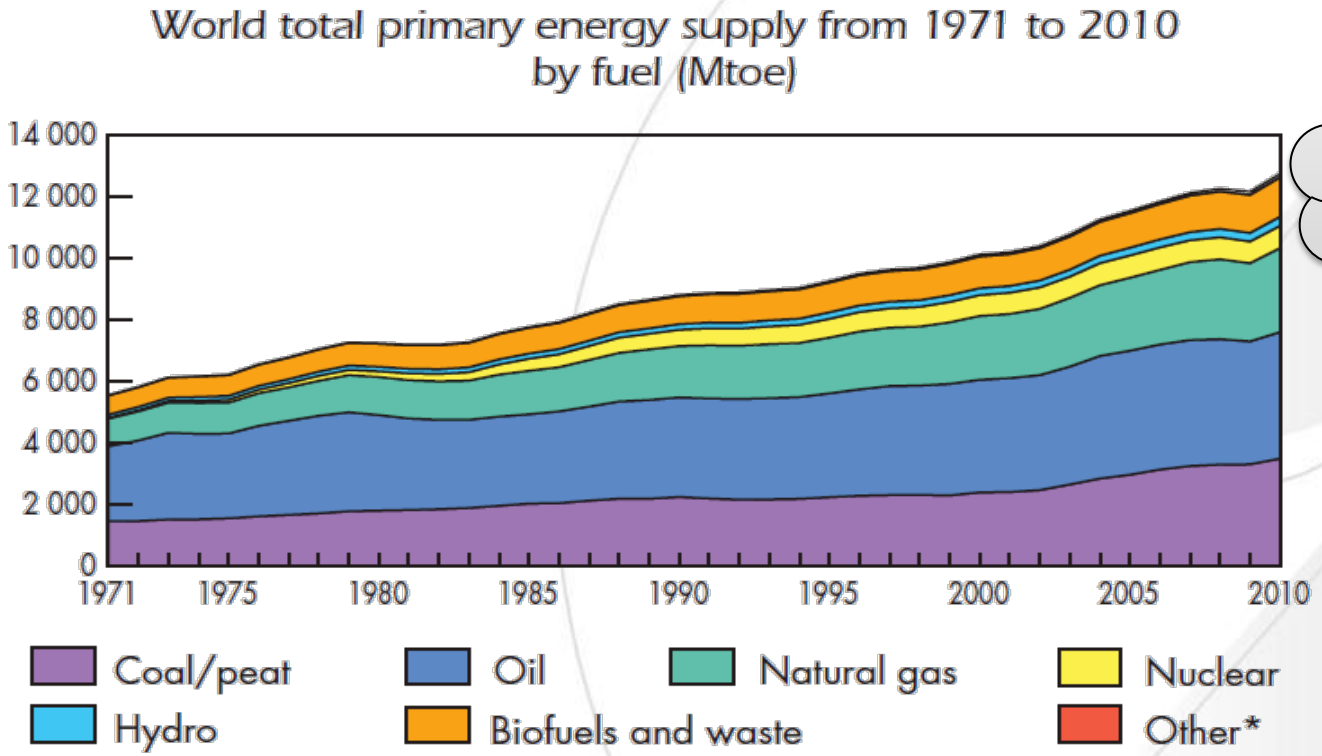
(dollars in thousands)

	FY 2010 Current Approp	FY 2012 Request
Biomass and Biorefinery Systems RD&D		
Feedstocks	36,212	16,000
Conversion Technologies	82,115	117,000
Utilization of Platform Outputs R&D	97,898	0
Integrated Biorefineries	0	25,000
Analysis and Sustainability	0	10,000
Biopower	0	22,500
Cellulosic Biofuels Reverse Auction	0	150,000
Total, Biomass and Biorefinery Systems RD&D	216,225	340,500

Sources DOE, 2012

↑ 57 %

3. COMPETITIVENESS WITH OTHERS ENERGY SOURCES



Competition of technologies ?????

Source: International Energy Agency, iea 2012.

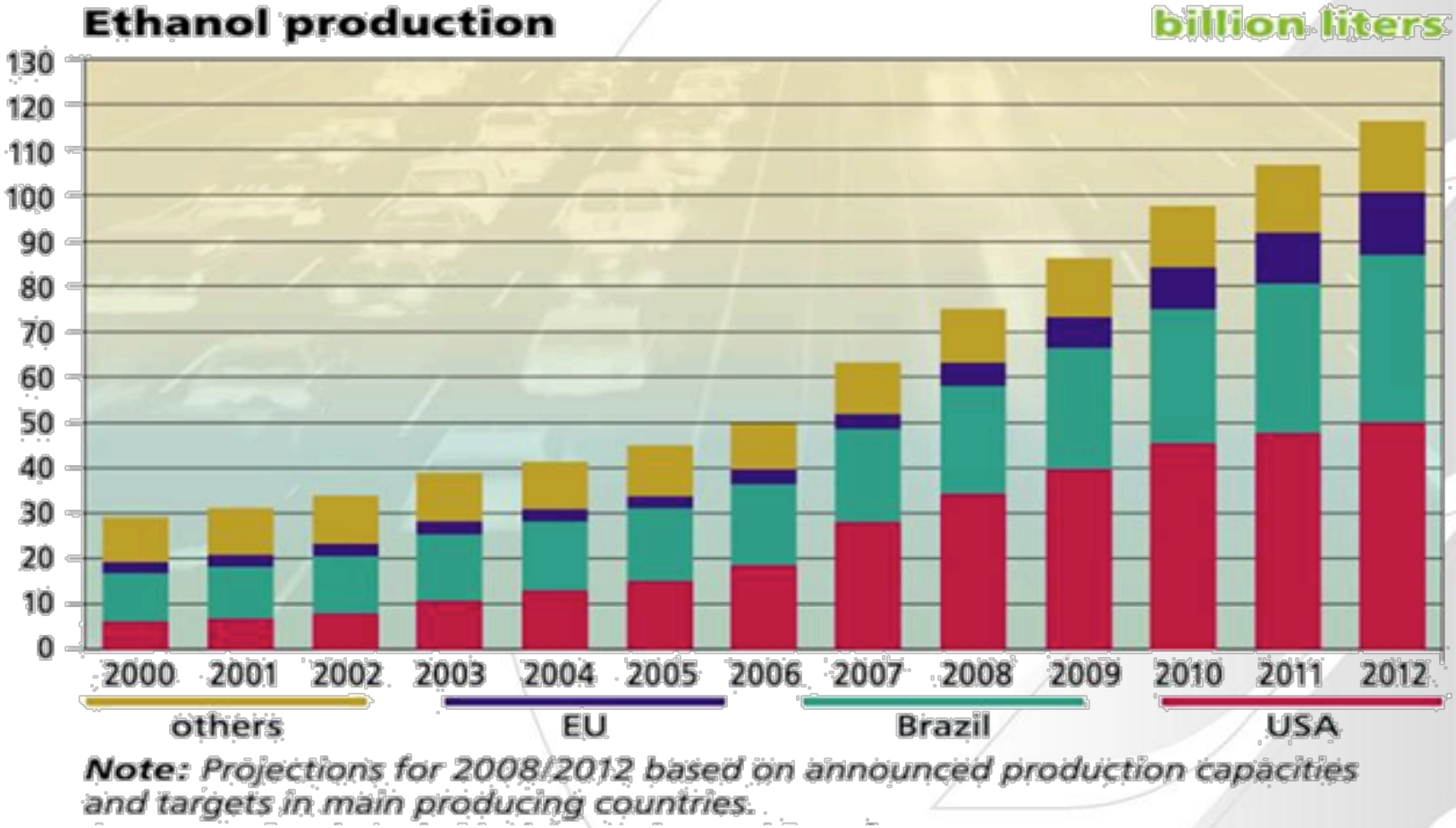
4. PRE-EXISTENCE INDUSTRY

TOP FIVE COUNTRIES – Annual additions in 2010

	New capacity investment	Wind power	Solar PV	Solar hot water/heat	Ethanol production	Biodiesel production
1	China	China	Germany	China	United States	Germany
2	Germany	United States	Italy	Germany	Brazil	Brazil
3	United States	India	Czech Republic	Turkey	China	Argentina
4	Italy	Spain	Japan	India	Canada	France
5	Brazil	Germany	United States	Australia	France	United States

- It is not difficult to add a 2th generation bioethanol plant to a existent sugar-cane or corn ethanol.
- Same for biodiesel to diesel.
- Can be difficult when there is not one preexistent Industry.

4. PRE-EXISTENCE INDUSTRY



Source: World Food Security, Planted Forests and Bioenergy, BRACELPA, June 2008

CHILE

CHILE

Regulations to use renewable energy and biofuels

Decree No. 11/2008, Ministry of economy. Quality for biodiesel and bioethanol, authorizes mixture of 2% and 5% with petroleum diesel and gasoline.

Circular N ° 30/2007, SII. Indicates that biofuels are not affected by the specific tax according to law 18.502/1986.

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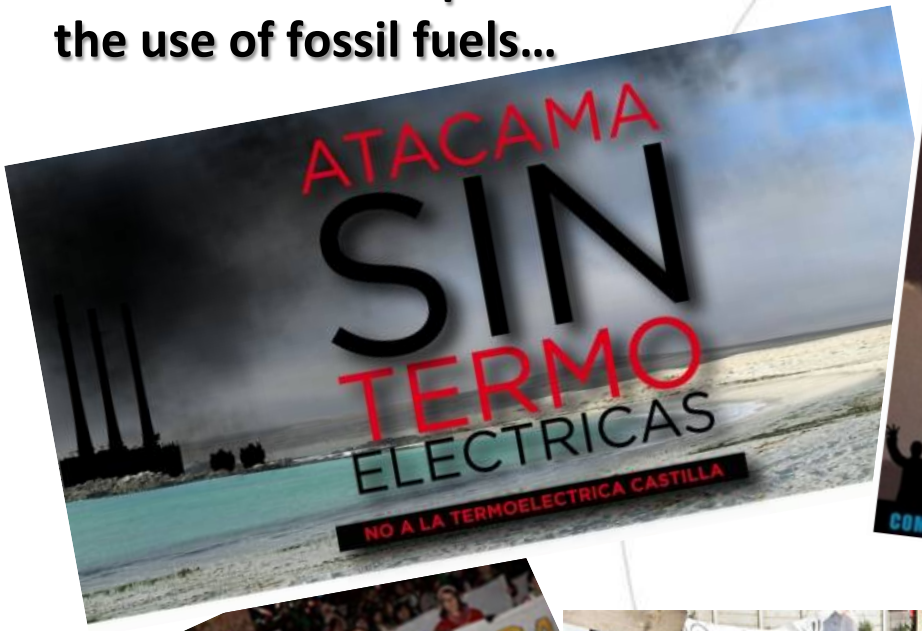
Environmental pressure

So far there is no pressure to use bioethanol, however, yes for decreasing the use of fossil fuels…



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Pre-Existent fuel Industry in Chile: ENAP *(Empresa Nacional de Petroleo)*

Distillation capacity: 220,000 barrels/day, with two refineries:

- Aconcagua (Concon)
- Bio-Bio (Talcahuano)

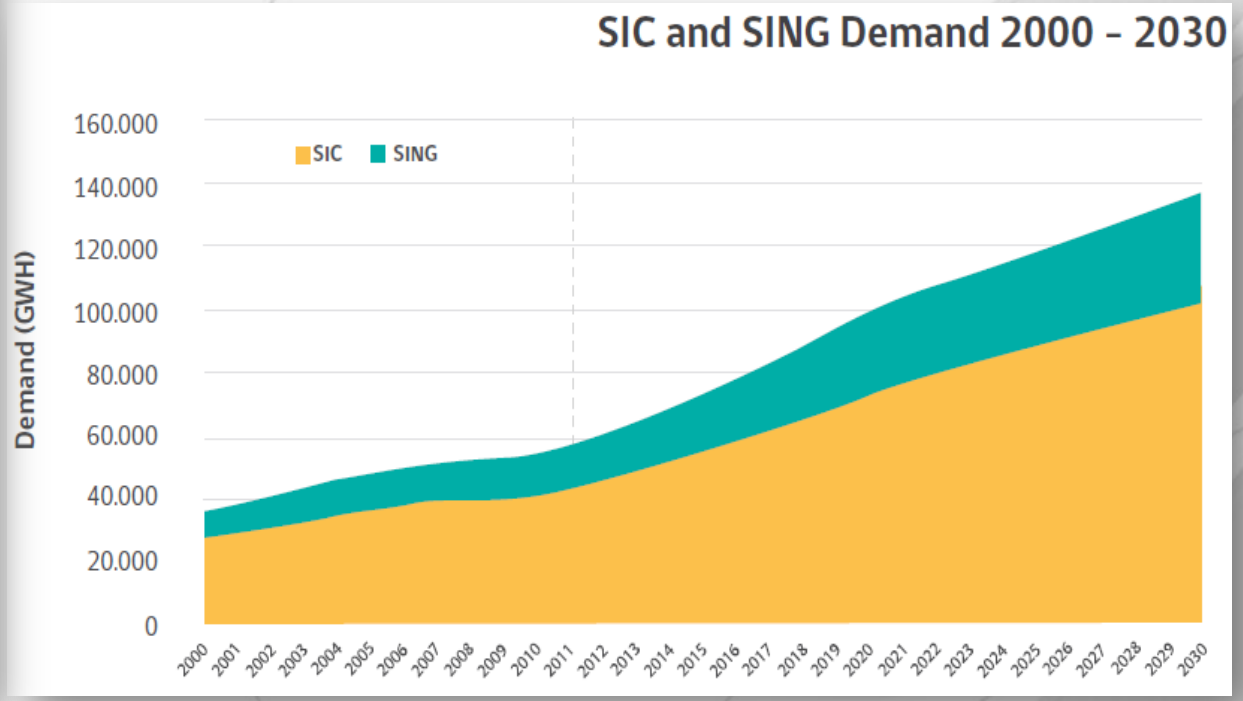
80% imported as oil,
processed into fuel in Chile

20% imported as fuel

Source: www.enap.cl

CHILE

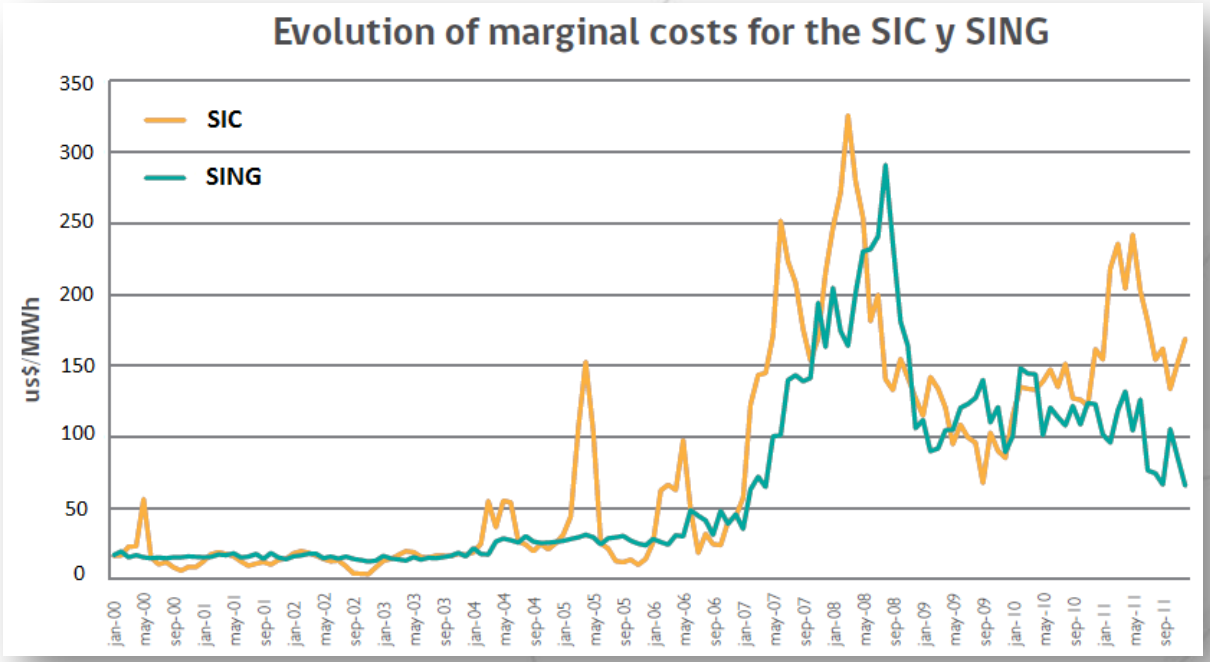
Electricity demand and prices



Source: National Energy Strategy 2012-2030. Energy Ministry, February 2012

CHILE

Electricity demand and prices



Source: National Energy Strategy 2012-2030. Energy Ministry, February 2012

CHILE

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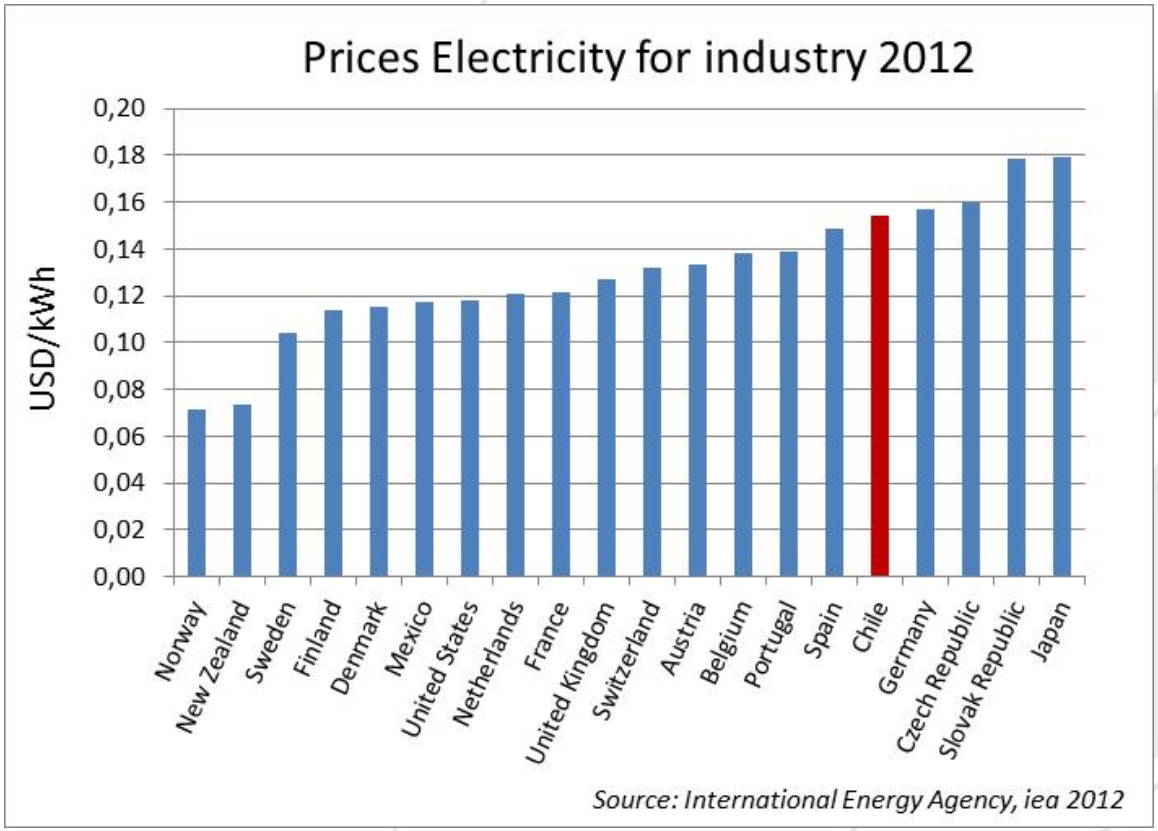


It means that a profitable technology for one country is not as profitable for another

CHILE

CONSORTIUM 2008	
LIGNOCELLULOSIC	BioEnercel S.A.
	BioComsa ©Biocomsa Consorcio Tecnológico de Biocombustibles S.A.

CONSORTIUM 2010	
ALGAES	ALGAE FUEL S.A.
	DESERT BIOENERGY S.A.
	BAL BIOFUELS S.A.

Source: Ávalos V., Ministerio de Energía, Nov 2011

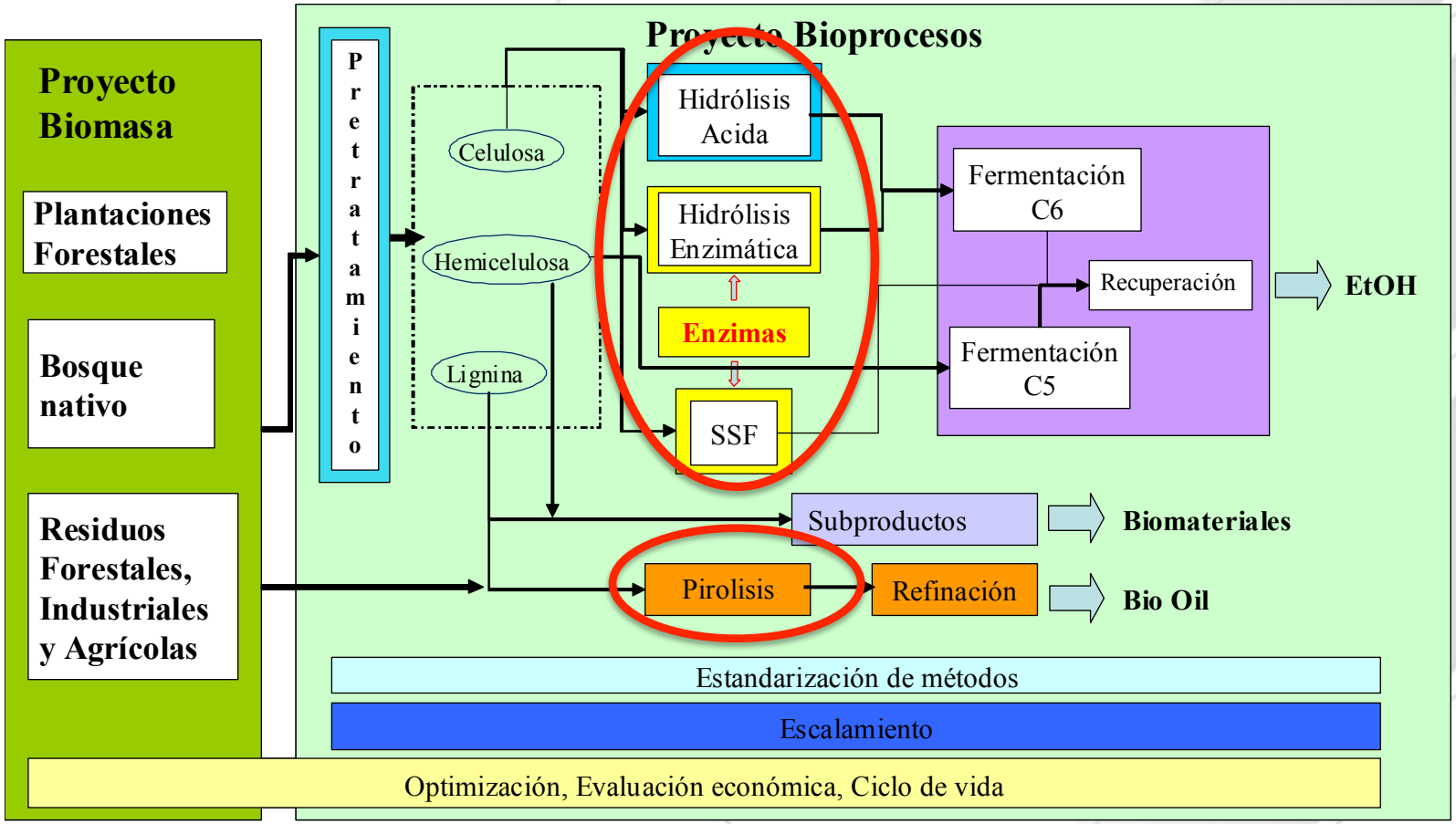
CHILE

BioEnercel S.A.

R&D Program

BIOMASS

BIOPROCESS



FEW COMPANIES TO BE OBSERVED

Process Yield

ZeaChem

- Hybrid process
- Highest net conversion efficiency to ethanol.
- Yield: 506 (l/BDT)

ENSYN

- RTP technology is commercial process that converts wood and other solid biomass to bio oil.
- Yields: 750 barrels/day (BOE) from 400 ODt.

Woodland Biofuels Inc.

- CPR™ process for ethanol -thermochemical
- Demo Plant Start up 2012
- Yield 488 (l/BDt)

Source: SusChemAlliance, Newsletter Fall 2012.

REMARKS

- There is not so far governmental regulations or incentives to promote the use of Biofuels in Chile

- The prices of market pulp tent to go down due the considerable amount of new capacity that will get in the business. How it will affect the strategy of the companies is a question mark.

- Based on the present fuel industry established in Chile biofuels in form of diesel and gasoline produced by thermochemical platform are “presently” more attractive.

SUGESTIONS

- The country and the environment would advantage if the government authorities to promote laws/incentives for production and use of biofuels in Chile.

- There are already very good candidates to develop Partnerships with potential technologies developers.

- The possibility to integrate second generation biofuels to a chemical pulping mill could maximize the profits for both industries, for example to get use of utilities, waste treatment and biomass logistics.

ARAUCO
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One vision on Biorefinery in Chile

Questions?

PUCON – CHILE
November 20th, 2012