

# **BIO-ELECTRICITY**

## **Efficient and Clean Production of Electricity from Biomass via Pyrolysis and Hydrogen Utilizing Fuel Cells**

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**Thermo Chemical Conversion of Biomass**



**BIO-ENERGY  
ENLARGED PERSPECTIVES**

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# PARTNERS

- **Universities:** Belfast, Patras, Twente
- **Research Institutes:** CNRS, ENEA
- **Industry:** Ansaldo Ricerche S.R.L., Johnson Matthey



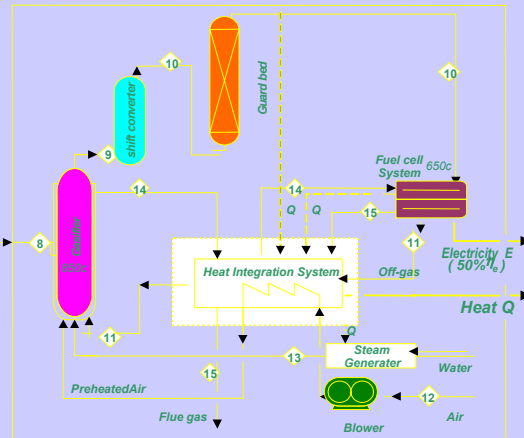
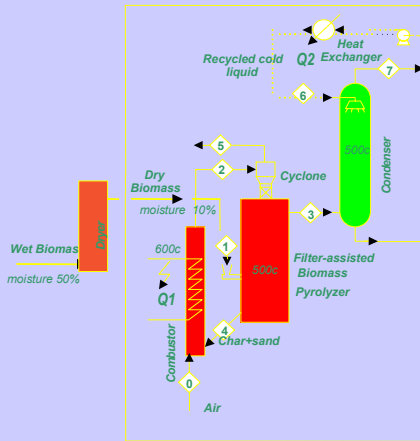
**TIME SPAN**

**1-12-2002 – 1-12-2005**

# CONCEPT

## Bio-oil Producer

## Bio-oil Processor



**Bio-oil production  
on large scale**



**Out of grid  
energy production  
(ca. 500 kW<sub>e</sub>)**

# OBJECTIVES

- **Production of hydrogen and electricity from bio-oil**
- **Catalyst and process development**
- **Small-scale demonstration in an integrated set-up**
- **Out of grid energy production (500 kW<sub>e</sub>)**
- **Low emissions / waste**
- **Cost and energy efficient**

# METHODOLOGY

Pyrolysis

**Biomass**



Fast pyrolysis  
**(FB with in-situ filters)**

**Bio-oil**



Catalytic conversion  
**(Bio-oil gasifier)**

**H<sub>2</sub>/CO**



Water gas shift  
**(Standard technology)**

**H<sub>2</sub>/CO<sub>2</sub>**

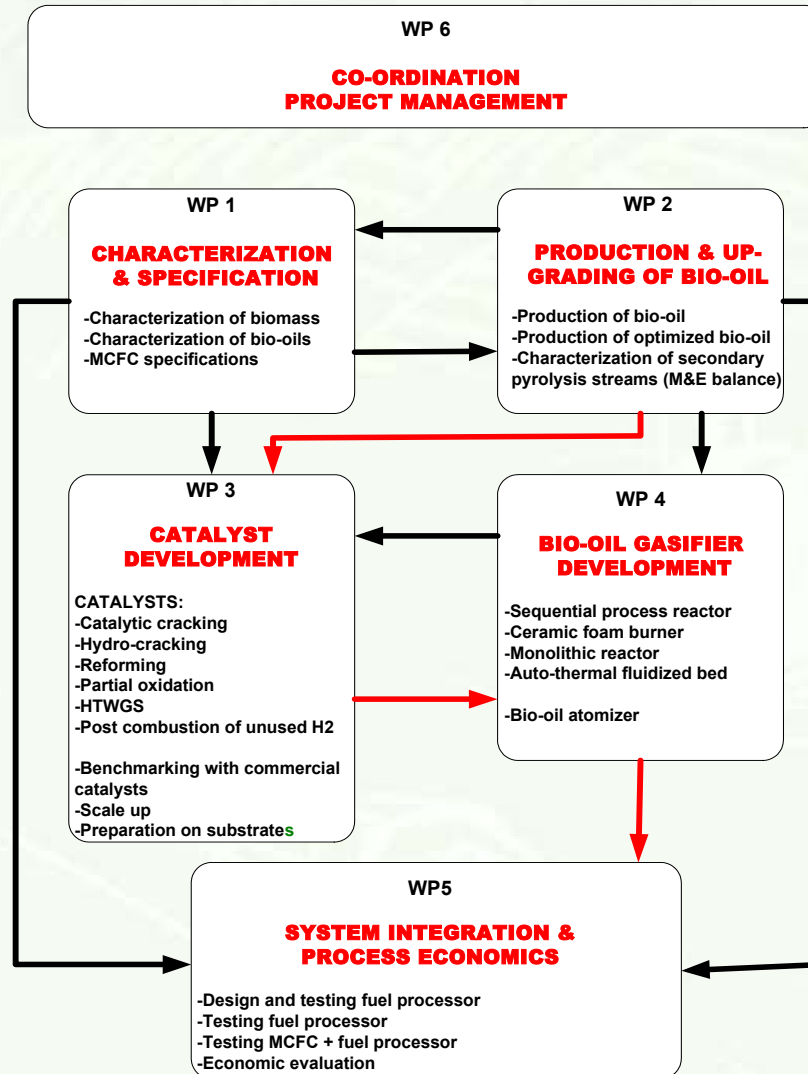


MCFC / post combustion  
**(Standard technology)**

**Electricity  
Heat**

Fuel processor

# WORKPACKAGES



# PRODUCTION & UPGRADING OF BIO-OIL

## Pyrolysis

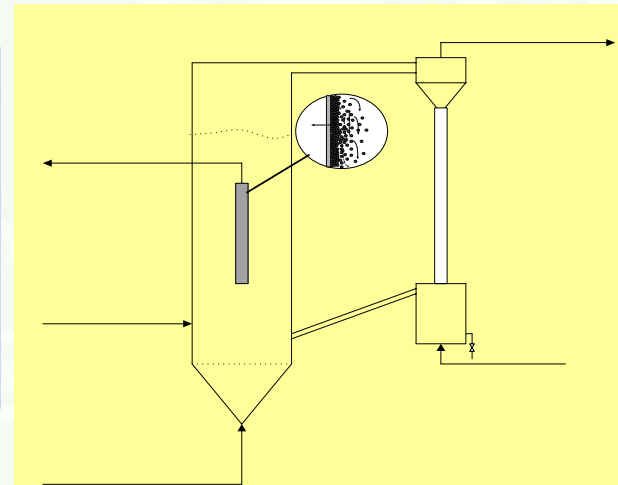


Source:  
[www.BTGworld.com](http://www.BTGworld.com)

## Char removal is a crucial issue

- Char acts as a vapor cracking/polymerization catalyst -> instable oil / processing difficulties
- Hot vapor filtration gives a high quality char free product.

## FB with In-situ filtering



# CATALYSTS DEVELOPMENT

## CATALYSTS

- Catalytic cracking
- Hydro-cracking
- Reforming
- Partial oxidation

<b>Steam reforming</b>	
<b>Metals</b>	<b>Carriers</b>
Pd	$\text{Al}_2\text{O}_3$
Rh	$\text{CeZrO}_2$
Ru	$\text{La}_2\text{O}_3$
Pt	
Ni	

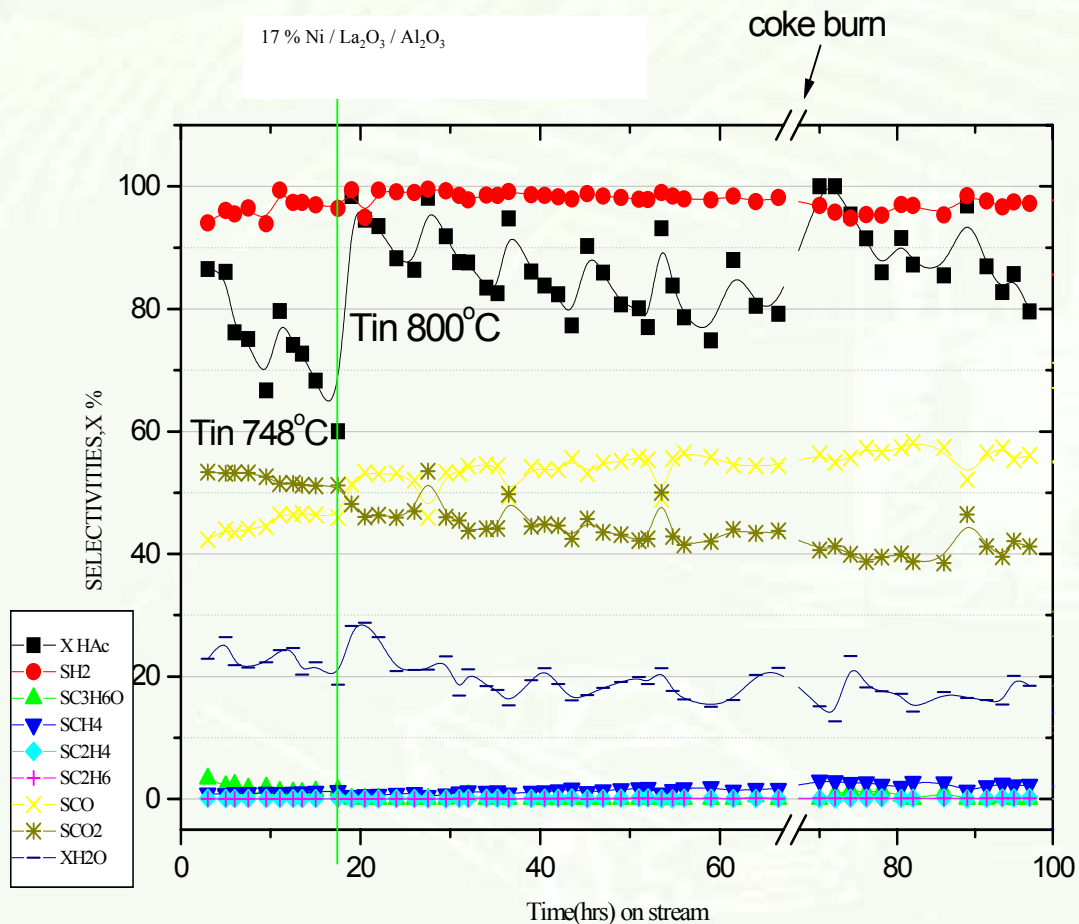
**Catalytic bio-oil gasifier**

**Testing with model compounds and real bio-oil**



# CATALYSTS DEVELOPMENT:

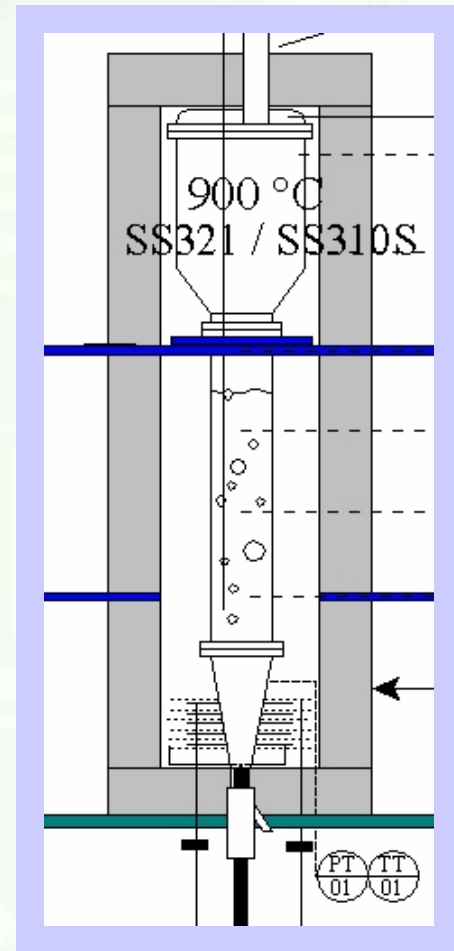
## *Steam reforming of acetic acid*



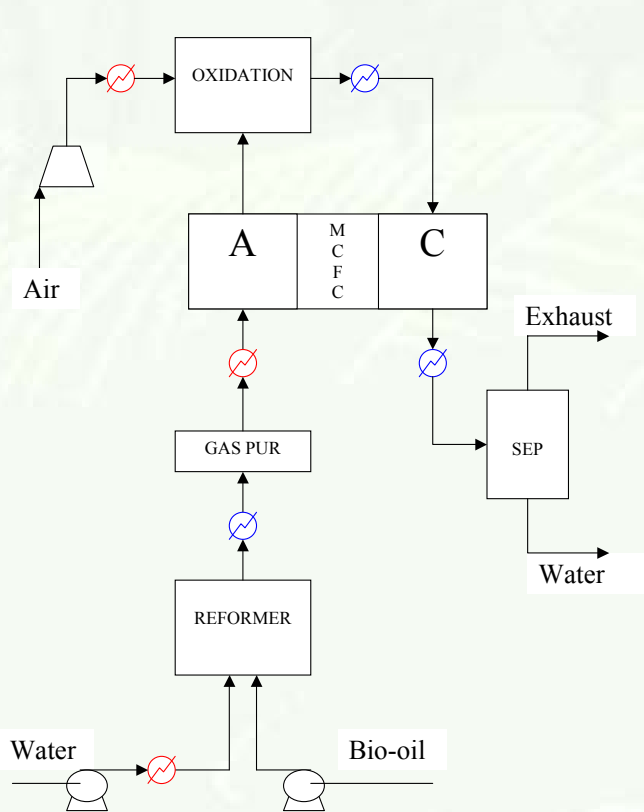
# BIO-OIL GASIFIER

## ***REACTOR DESIGN***

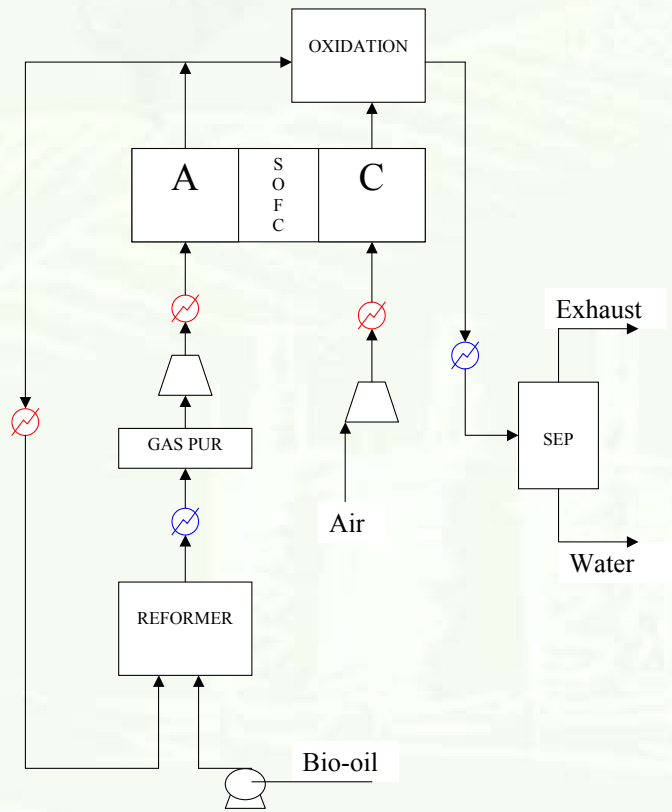
- **'Cold' bio-oil injection**
- **High heat duty for reactor**
- **Regeneration of catalyst**



# SYSTEM INTEGRATION



- Pure steam reforming
- Simple design
- Low quality heat released



- Steam and CO<sub>2</sub> reforming
- High electric efficiency
- High quality heat released

# CONCLUSION

- **Project is on schedule after 10 months**
- **Bio-oil samples delivered for characterization**
- **Selection/development catalyst for bio-oil gasification is a crucial task**
- **Reforming of bio-oil model compounds is possible**
- **Fluid bed technology will be applied**
- **SOFC offers better opportunities than MCFC**