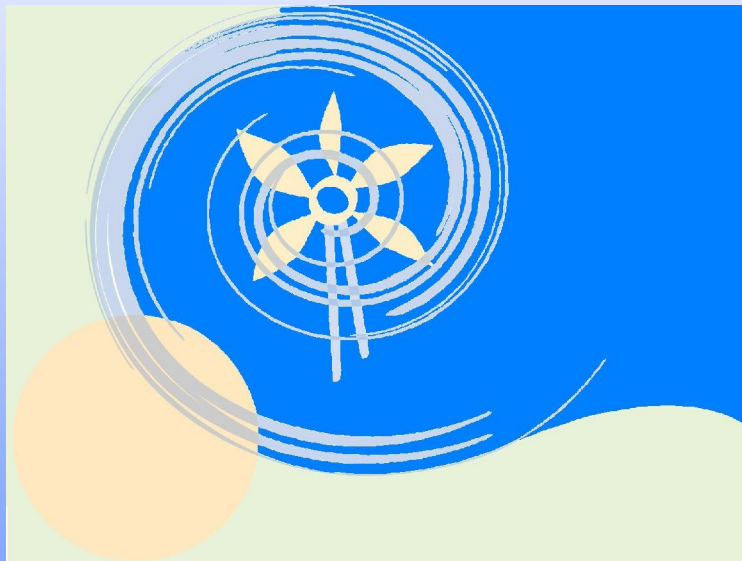


# Co-processing of Upgraded Bio-Liquids in Standard Refinery Units

FP6 Biomass Contractors' Meeting  
Jönköping, 31 May 2006



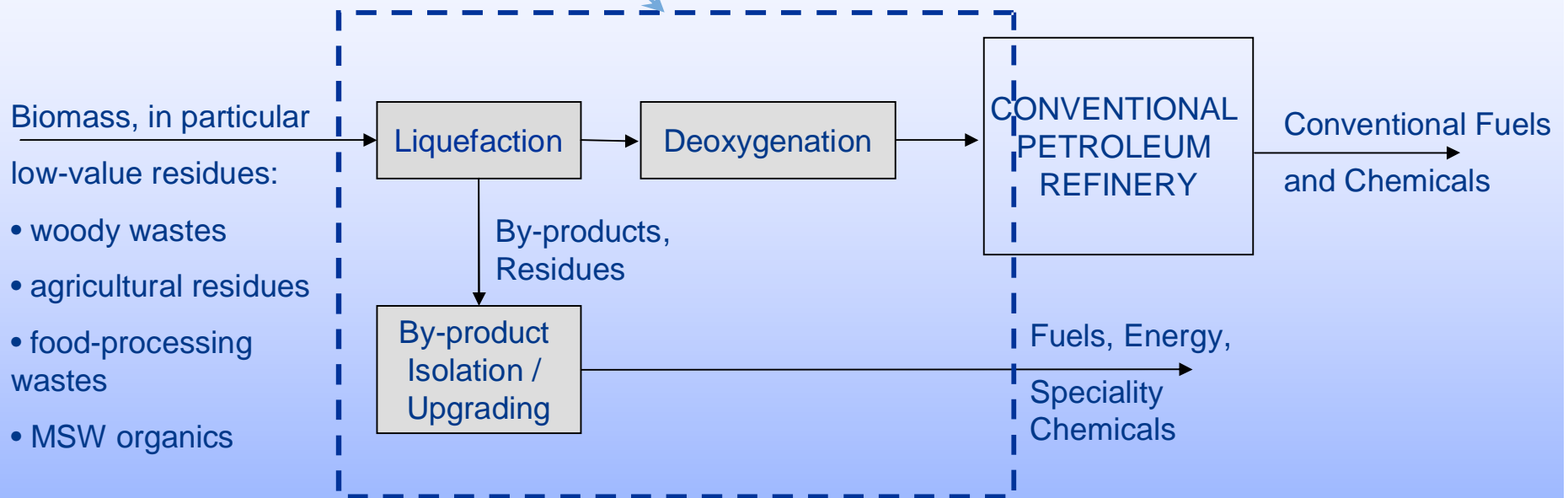
Yrjö Solantausta  
VTT

# **BIOCOUP – An IP-Project with 17 Partners from Eight Countries**

- û **Supervisory board: VTT, University of Twente, Shell Global Solutions International, CNRS**
- û **Other partners: BTG, ARKEMA, UHPT, Metabolic Explorer, STFI-PACKFORSK, University of Groningen, Technical University of Helsinki, Institute of Wood Chemistry – Hamburg, Slovenian Institute of Chemistry, Boreskov Institute of Catalysis, ALMA Consulting group, Albemarle, CHIMAR**
- û **Call December 2004, negotiation April 2005 ->, Annex I completed January 2006, Start-up May 1, 2006**
- û **Duration 5 a, overall budget 13.3 M€, EC grant 7.6 M€**



# Main Focus and Limits of The Biocoup Biorefinery Concept



- high degree of integration with existing infrastructures
- primary liquefaction may be physically removed from deoxygenation; e.g. primary liquefaction is integrated with CHP plant or with paper mill, whereas deoxygenation is integrated with the oil refinery



# A Distributed Biofuel Production Chain - Advantages and Long Term Goals

- û The long term goal: A liquid biofuel chain, which is distributed, flexible and may be implemented stage-wise
- û **Distributed** - advantages in transportation logistics (relatively small unit for biomass conversion, initial separation, transportation of liquid instead of solid to central refinery)
- û **Flexible** - several uses for products, which may be exploited depending of market demand (replace fuel oils in ovens, boilers, power plants, and refinery feed)
- û **Stage-wise implementation** - an industrially credible development path (the system will be built in several stages founded on industrially independent units, first to replace mineral fuel oils, later as a refinery feed)

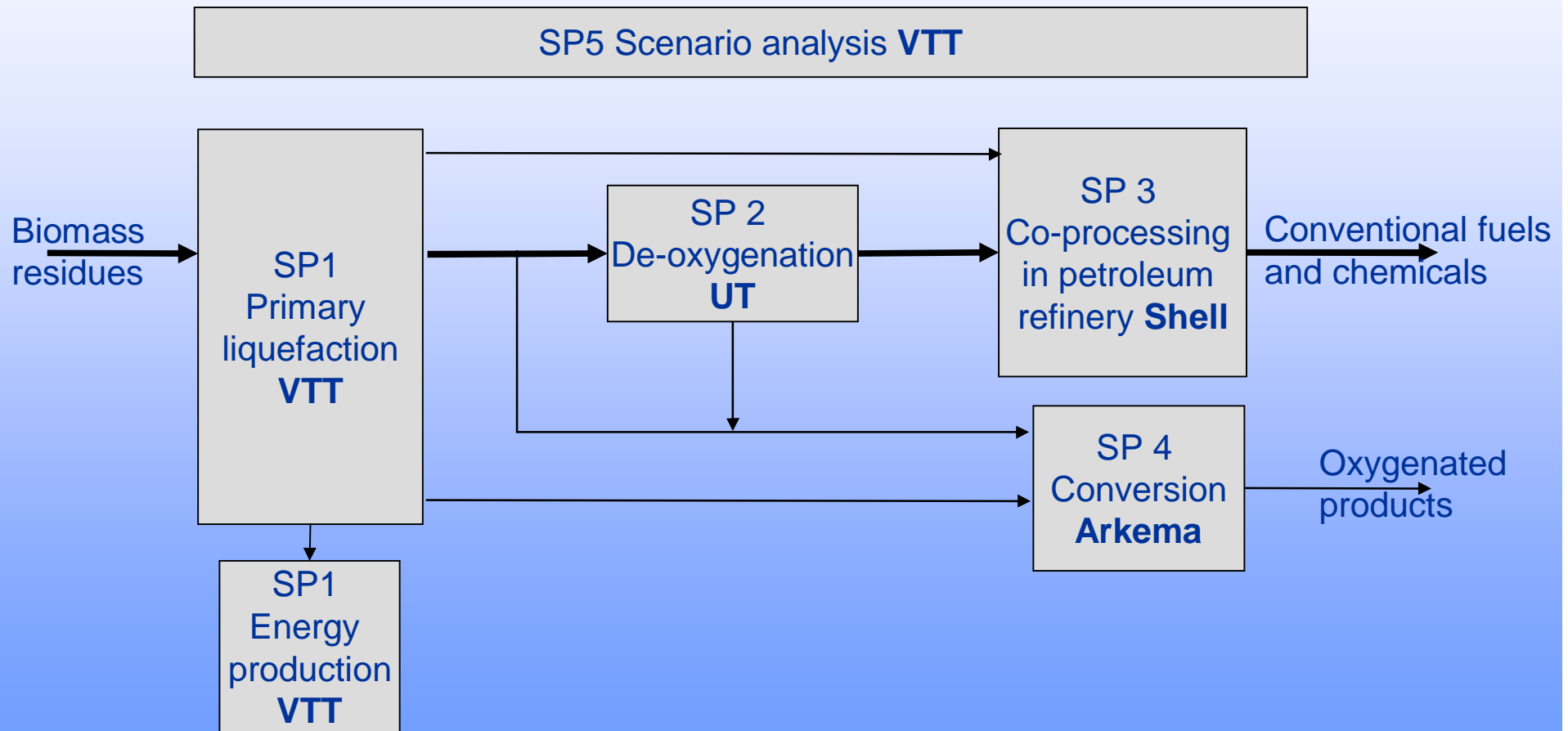


# The Overall Objectives in Six Sub-Projects and Resources

1. **Biomass liquefaction and energy production: To reduce bio-oil production costs; 10 % of the manpower**
2. **Upgrading technologies: To develop de-oxygenation technology and scale it up to process development unit-scale; 30 %**
3. **Evaluation of upgraded bio-liquids in standard refinery units: To assess the viability of upgraded bio-liquids co-processing in a standard refinery; 17 %**
4. **Conversion to chemicals: To identify optimal recovery and fractionation strategies and technologies for the production of discrete target compounds from bio-liquids; 31 %**
5. **Scenario and life cycle analysis: To outline a low-risk, low-cost development path for the most promising bio refinery chain(s), a path based on stage-wise validation, demonstration and implementation; 4 %**
6. **Transversal activities: Training, management, exploitation and dissemination; 9 %**



# BIOCOUP - Concept Mass Flows, Sub-Projects and Responsibilities



# SP 1: Biomass liquefaction and energy production

- û **The overall objective of the SP is to reduce the costs of primary bio-oils produced through**
  - ü an innovative integrated bio-oil concept from a number of biomass feedstocks (initially especially residues from forestry industries)
  - ü improving solid separation from primary bio-oils, and
  - ü developing a fractionation stage after the primary liquefaction stage.
- û **Integration of bio-oil production for example to a Combined-Heat-and-Power (CHP) plant in energy and pulp and paper industries is envisioned.**



# SP 2: Upgrading technologies

- û **To develop technology for decreasing the oxygen content of primary bio-liquids. Primary bio-liquids typically have oxygen contents of ca. 50wt% and cannot be processed in standard refinery units serves. Current de-oxygenation processes are not mature and far too expensive due to high hydrogen costs. Herewith the baseline for the development is defined. Measure for success is requisite oxygen content for co-processing (defined in SP3).**
- û **The means to achieve this objective are:**
  - ü Development of optimal reactors and catalysts and determination of the optimal process conditions for the de-oxygenation processes considered, being high pressure thermal treatment (HPTT), decarboxylation (DCO) and hydrodeoxygenation (HDO);
  - ü Testing and optimizing of several deoxygenation technologies (combinations of HPTT, DCO and HDO) in a PDU of 10 kg/hr.



# SP 3: Evaluation of upgraded bio-liquids in standard refinery units

- û **The products derived from biomass-derived refinery co-processing will be intrinsically chemically indistinguishable from their fossil fuel based counterparts.**
- û **This will allow a seamless integration of bio-refinery co-processing products to the end consumer for products such as transport fuels and chemicals, and provide an important stimulus to biomass acceptance and further technological development of biomass production routes.**
- û **Assessment of the technical feasibility and economic viability of co-processing upgraded liquefied biomass on a laboratory scale in**
  - ü fluidised catalytic cracking (FCC) with representative FCC feedstocks
  - ü hydro treating in continuous micro flow units
  - ü thermal cracking units using known laboratory scale process parameters.
- û **The effect of the added bio-component on catalyst activity, degree of conversion and overall product quality will compared with the base-line comparative situation of processing conventional (FCC and HDS) feedstocks.**



# SP 4: Conversion to chemicals

- û **The key advantage of the produced bio-liquids over crude oil is their high content of oxygenates.**
- û **Therefore the main objectives of SP 4 are to establish technologies for the production of discrete target oxygenated compounds (phenolic fractions, organic acids, aldehydes and sugars from the bio-liquids produced in SP 1 and SP 2 and the utilization of these compounds to derive industrial oxygenated chemicals and products.**
- û **The key-objectives of SP 4 are listed below:**
  - ü Selection of discrete oxygenated target compounds and industrial oxygenated chemical products
  - ü Isolation and fractionation technologies for target oxygenated compound fractions
  - ü Chemical and biochemical synthesis routes
  - ü Generation of design data and conceptual designs for the recovery and fractionation operations



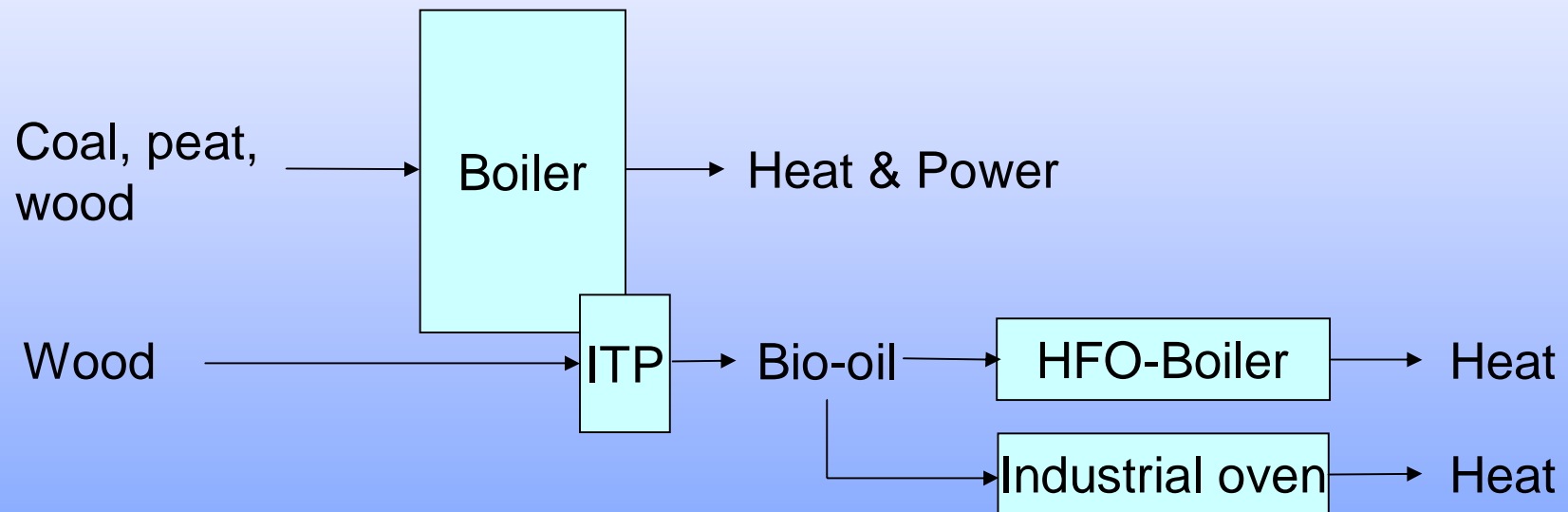
# SP 5: Scenario and Life Cycle analysis

## û **The main objectives of SP 5 are as follows:**

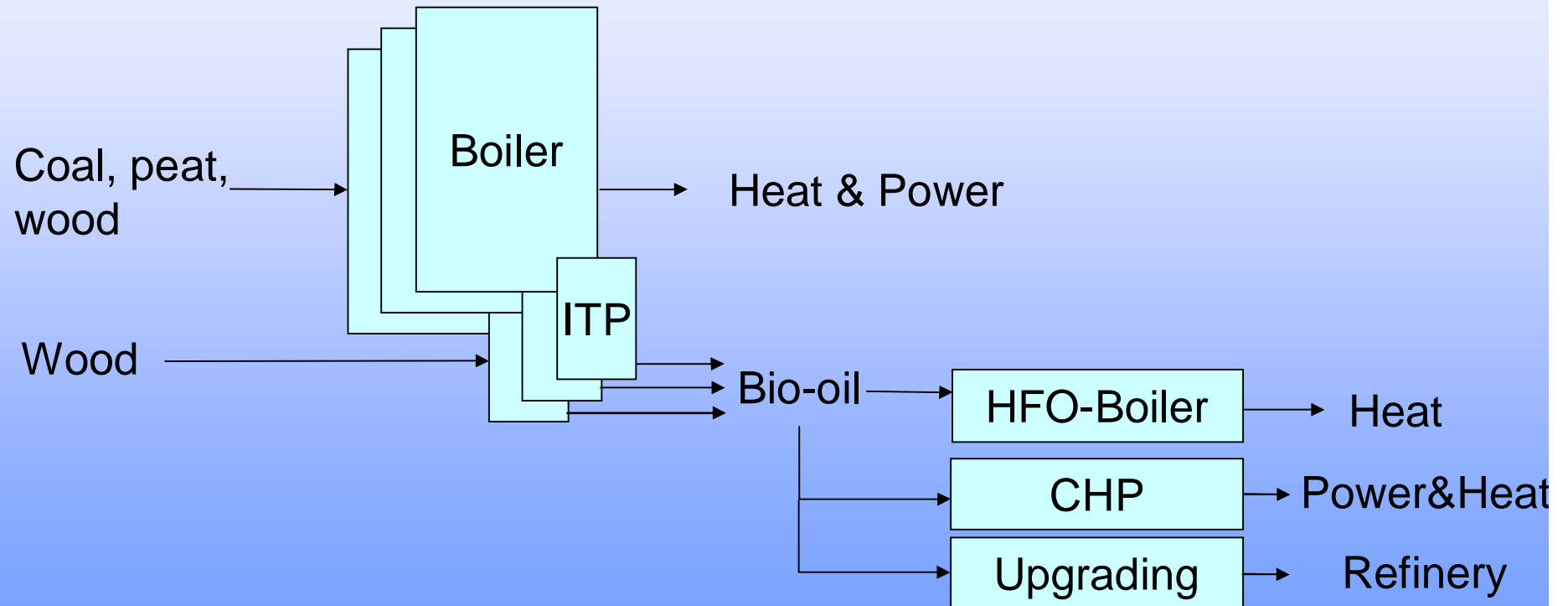
- ü To identify, within the framework of the present biorefinery concept, the most promising optimised biomass-refinery chain(s) (biomass feedstocks → final products) through evaluation of the technical, economical and LCA (life-cycle analysis) performances of such chains and to assess the economic competitiveness of the most promising chain(s) in both the short and medium term.
- ü Gathering/generation of economic data for all relevant operations, compilation of a series of promising chains within the framework of the present biorefinery concept, economic evaluation and optimisation of the chains.
- ü Evaluation of co-processing integration and impacts (emissions, blending, product quality) and development of bookkeeping methods for bio-inputs to conventional refineries



# Initial Industrial Implementation: Demonstration of Production and Utilisation of Bio-oil to Replace Fuel Oil



# Further Industrial Implementation: Duplication of Production and Demonstration of Higher Value Uses for Bio-oil



# Why we will be successful

- û **Integrated approach – industrial development path identified and integration to existing industries**
- û **Overall chain approach – realistic visions for feedstocks availability and innovation in processing**
- û **Complementary partnership – from fundamentals to industrial applications**



# Acknowledgements

- û **Biocoup partners**
- û **Paterson McKeough, Colin Schaverien, Wolter Prins, Sascha Kersten, Andre deHaan, Claude Miradotos, Christine Duch**

