JRC/EUCAR/CONCAWE
WTW Analysis of European Road Fuels

A European Perspective on fuels LCA Modelling

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concawe

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- LCA models
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  - Boundary issues: direct and indirect effects
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- LCA as a regulatory tool
- What should Research concentrate on?

The JEC WTW study: historical background

- Origin: rising interest in biofuels and other alternatives to road fuels (e.g. CNG) in the late 90s
  - Desire to understand overall impacts
  - Increasing awareness of the GHG emissions issue
- Early work:
  - Research Institutes and Academia mostly in Germany and Scandinavia
  - Some studies sponsored by governments (e.g. France with ethanol and bio-diesel)
  - Generally limited scope, concentrating on particular fuels/pathways
  - CONCAWE published a report on the GHG balance of biofuels in 2002, based on a literature subject
- European General Motors study published in 2002
  - Comprehensive review of alternative fuel pathways in the EU context

The JEC WTW study

- JEC consortium formed in 2000 started working on WTW study in 2002
  - Joint Research Centre of the European Commission
  - EUCAR (Auto industry pre-competitive Research body)
  - CONCAWE (refining industry)
- Objectives
  - Well-to-wheels energy use and GHG emissions assessment of a wide range of automotive fuels and powertrains relevant to Europe in 2010 and beyond
  - Consider the viability of each fuel pathway and estimate the associated macro-economic costs
- Conceived as an evergreen study
  - Version 1 published in December 2003
  - Version 2 published in January 2007
  - Version 3 partial results released in December 2008
  - Version 4 will include additional options a/o electric vehicles
- Now used by many as the reference study in EU
  - JEC consortium advised the EU Commission and supplied data for the development of the Renewable Energy Directive GHG methodology and default values

Well-to-Wheels Pathways

Resource

- Crude oil
- Coal
- Natural Gas
- Biomass
- Wind
- Nuclear

Inc. preliminary views on Carbon Capture and Sequestration

Fuels

- Conventional Gasoline/Diesel/ Naphtha
- Synthetic Diesel
- CNG (inc. biogas)
- LPG
- MTBE/ETBE
- Hydrogen (compressed / liquid)
- Methanol
- DME
- Ethanol
- Bio-diesel (inc. FAEE)

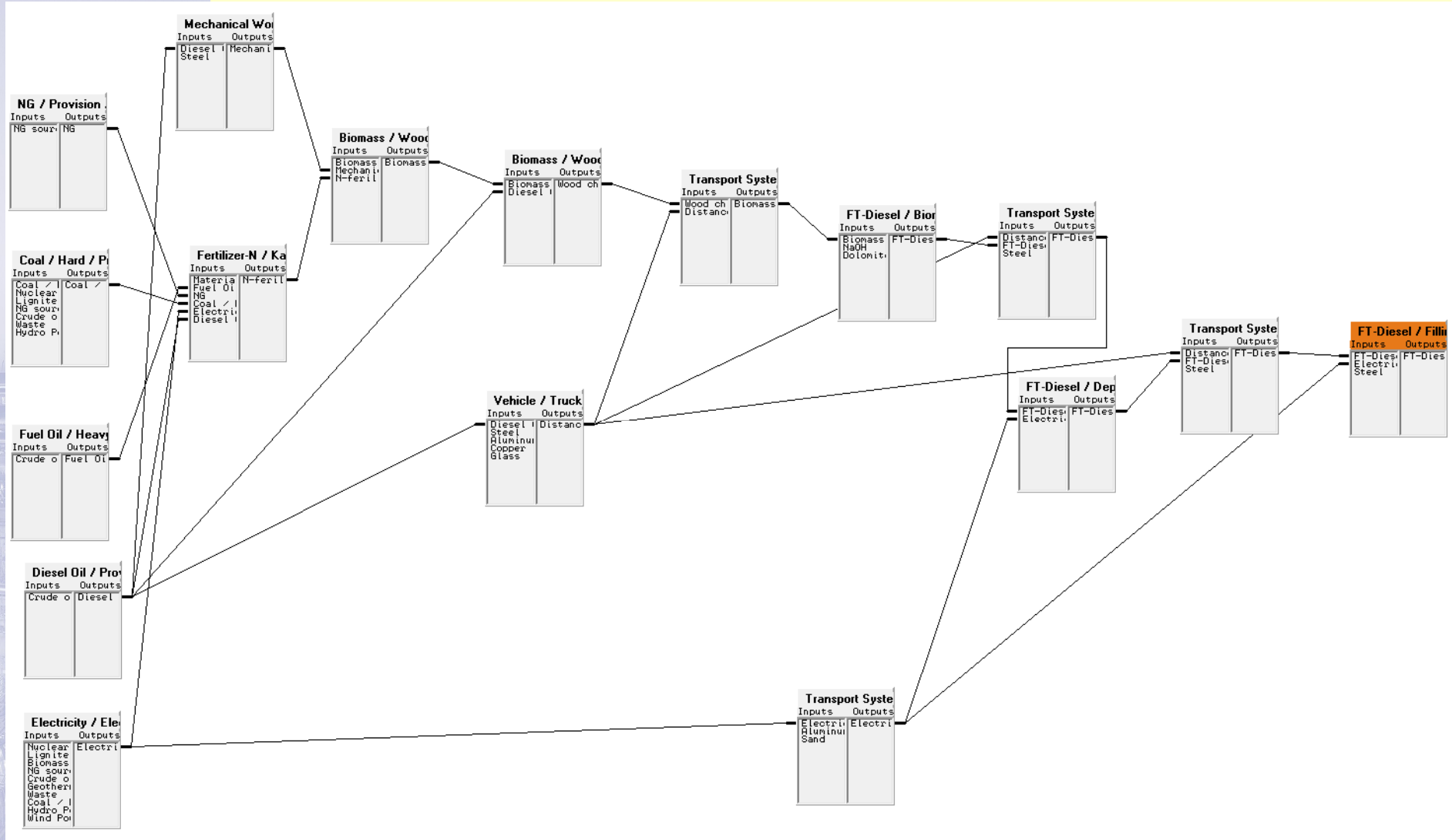
Powertrains

- Spark Ignition*:* Gasoline, LPG, CNG, Ethanol, H_2
- Compression Ignition: Diesel, DME, Bio-diesel
- Fuel Cell
- Hybrids: *SI, CI*, FC
- Hybrid Fuel Cell + Reformer

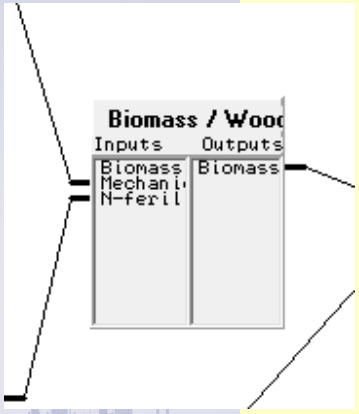
JEC uses the LBST E³ database

- A proprietary software which
  - Stores data in the form of discrete “processes”
    - e.g. Rapeseed crushing, Electricity generation from coal, Transport by road truck
    - Data includes energy and/or mass flows, emissions, uncertainty ranges and probability distribution
  - Lets the operator combine processes into a chain or “pathway”
  - Calculates the resulting footprint of the pathway (energy, GHG, other emissions etc)
  - Reports results in Excel format including optional Monte Carlo analysis

A (BTL) pathway as represented in the E³ DB



A process (wood growing) in the E³ DB



Process Description

Close Windows

HEAD (1)

Process Name: Biomass / Wood Plantation / CONCAWE

Project Name:

Process Type: **Energy Conversion**

Main Output: Biomass

Main Input: Biomass

id_group : LBST

id_timestamp : 19/12/2007 17:05:12

Copy to clipboard

DATA - COPY

DATA - INSERT

IN / OUT (3)

Material: N-ferilizer

Add MainIn | Add MainOut

IO_Type: Input

Construction Material

Amount: 0.000486 kg/kWh

Distribution: Normal | Param1: 0.000389 | Param2: 0.000486 | Param3: 0.000973

Notes:

Murach, D.: 25 kg of synthetic N fertilizer;
Assumption: poplar yield = 10 t dry matter;
Kaltschmitt 2001: LHV (poplar) = 18.5 MJ/kg
=> 25 kg / (10*18500/3.6 kWh)

BASICS (2)

Time Horizon	Process Scale kWh/h	Data Range
2000	1000	Average

Show Usage

General Data | Economic Data | Emissions | N2O, CH4 | Reference

CH4	CH4 Distribution	CH4 Param1	CH4 Param2	CH4 Param3
0		0	0	0

N2O	N2O Distribution	N2O Param1	N2O Param2	N2O Param3
0.0091	DoubleTriangle	0014249235	0037401915	9985456467

Chosen I/Os:

MATERIAL_NAME	IO_TYPE	AMOUNT
Biomass source	Input	1
Mechanical Work	Input	0.0015
N-ferilizer	Input	0.000486
Biomass	Output	1

Should we debate LCA “models”?

- The word “model” suggests some form of mathematical representation that mimics reality through a kind of artificial intelligence
- LCA does aim at representing reality but it is a straightforward and mostly linear process
  - It is mostly about choices
  - The “model” is simply a number cruncher
- Two main issues
  - **System boundaries**
  - **Underlying hard data**

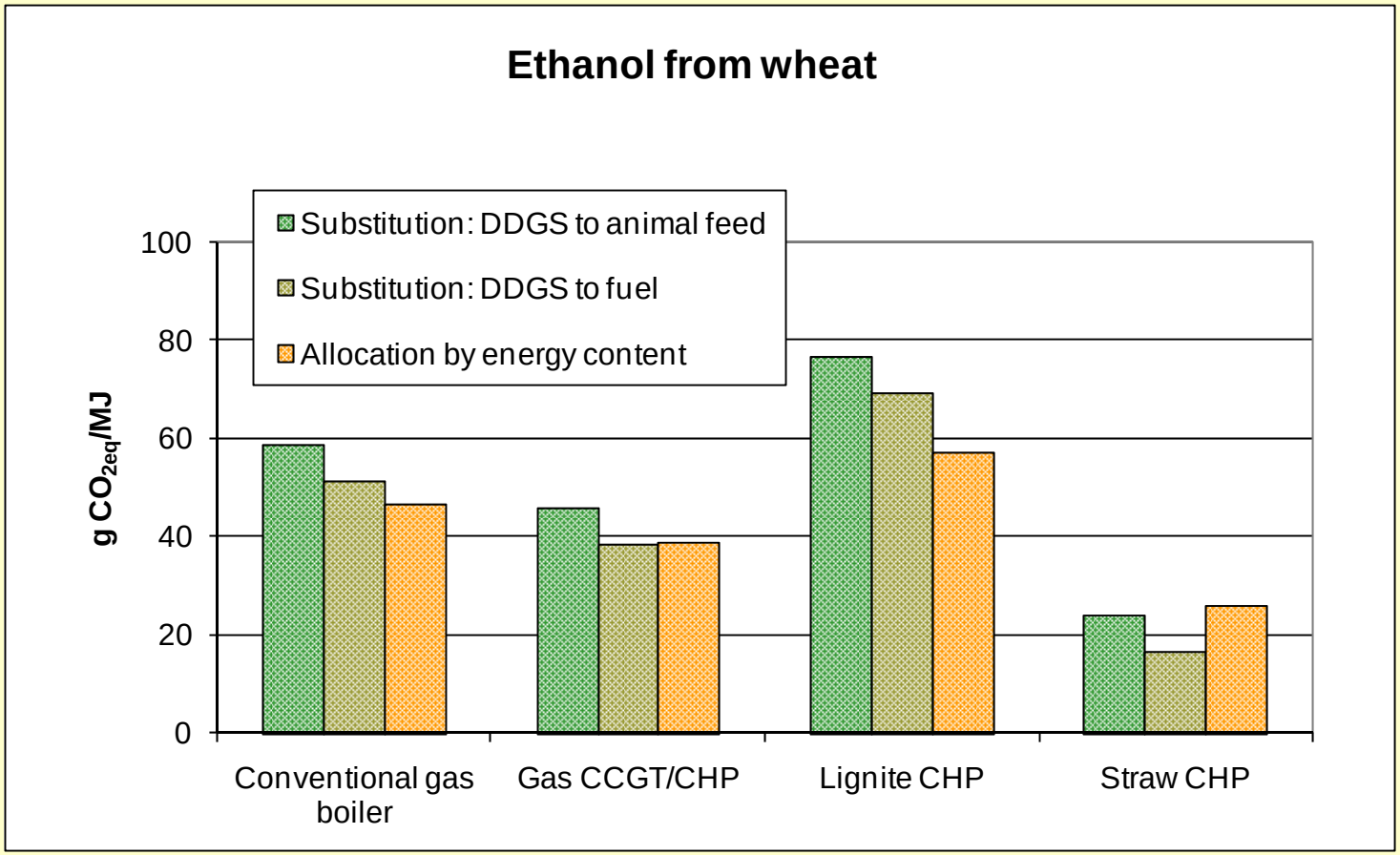
Pitching GREET v. JEC or GHGenius or any other “model” risks missing the point

- **The question must be what choices have been made, what options have been favoured**
- **Open-book and transparency are essential**

Boundary issues: Direct effects

- Direct effects are those readily identifiable as part of a chain. They are mostly under the control of the chain actors
- Accounting for co-products
- System expansion (substitution)?
  - Where to stop?
- Allocation?
- How far does one drill down:
- Agricultural inputs?
  - Fertiliser manufacture?
    - Sulphuric acid manufacture?
      - Sulphur production?
- What time scale to consider?
- Crop rotation
- Forestry has very different time scale
- Soil carbon stock changes are generally slow

Impact of accounting for co-products



- **Different co-product accounting methods can have significant effects**
- **The magnitude can be different for different chains**

Boundary issues: Indirect effects

- Indirect effects are more speculative and subject to assumptions and scenarios
- They are mostly outside the direct control of the chain actors
- When related to land use impacts do not directly affect the chain and can be considered separately

- Distinction between direct and indirect not always “black and white”
  - When using system expansion, accounting for co-products could be construed as indirect effects

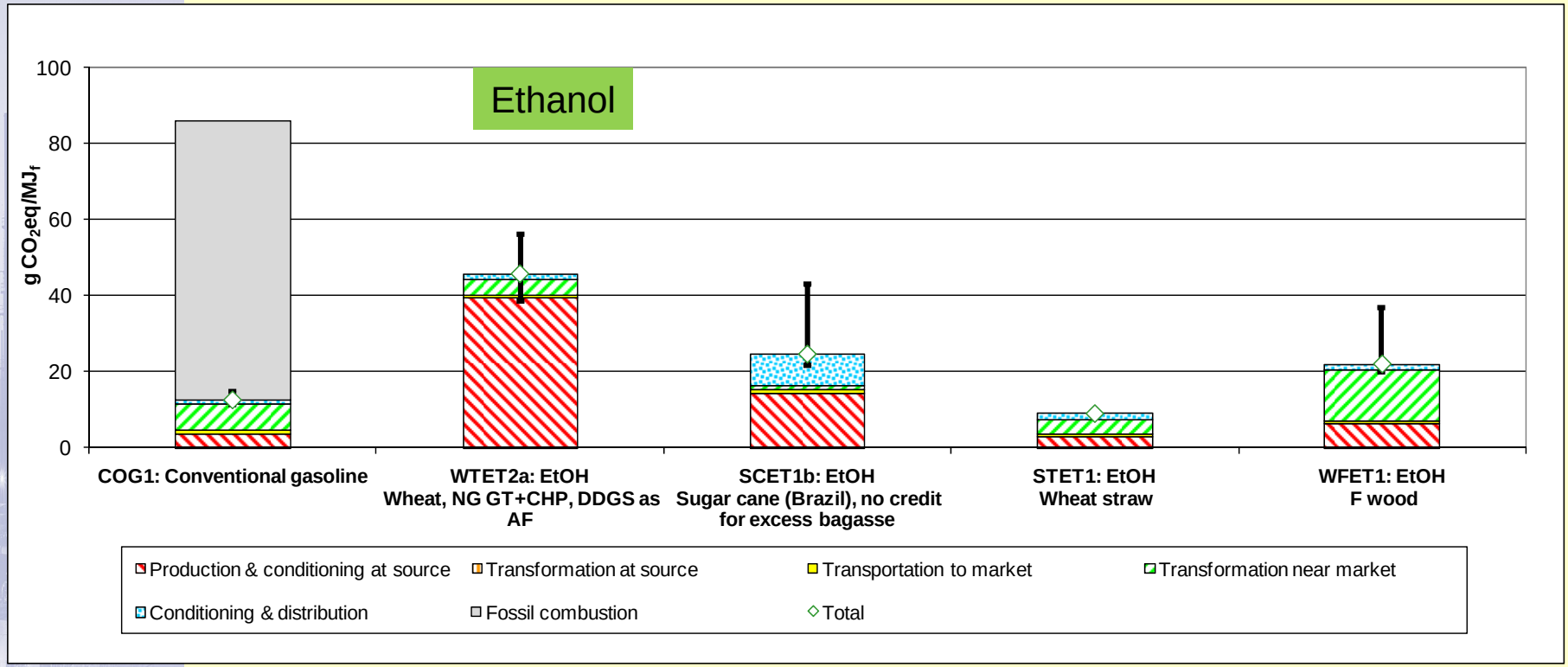
A view on Indirect Land Use Change impacts

- ILUC effects are real and may be very large
  - They may negate the benefits of certain pathways for many years
  - They may also be positive
- They are highly uncertain and speculative
  - They involve complex interactions of many parameters often outside the agricultural sector
  - Simplistic modelling and approaches may lead to erroneous conclusions and be counterproductive
- They are caused by policies rather than by individual actors
  - They must be assessed at the level at which the policy impacts
  - They must be addressed through policy changes
  - Retrospective approaches may be the only sensible ones
- Addressing Direct LUC without addressing Indirect LUC will be largely window-dressing: Land Use in general needs to be addressed

Data issues

- Representation of the diversity of real-world
  - Cultivation practices
  - Soil and climate characteristics
  - Yields
  - *What geographic envelope is being represented?*
    Most agricultural parameters have a strong local component
  - Processing schemes
  - *How many different pathways?*
  - *Is reliable data available?*
- Timeframe: How to represent future changes?
  - Compromise between longer term view and credibility
  - 5-10 years is usually a fairly “safe” period in view of development cycles of industrial products and processes
  - One uses “learning curves” at one’s peril…
- How to understand and estimate indirect effects?

JEC concentrates on the chains



We use data representative of the EU average

Uncertainties

Need to differentiate between

- Diversity of circumstances leading to significantly different results e.g.
  - Ethanol production schemes
  - Soil characteristics leading to different N_2O emissions
  - *What level of disaggregation is required, justified, manageable?*
- Sources of uncertainties due to lack of data or lack of understanding
  - N_2O emissions from crop production
  - Soil carbon retention and release
  - Indirect effects
  - *How to improve knowledge and obtain relevant information?*

However detailed and researched
the LCA process will only represent an approximation of reality
Its outcome will be uncertain and subject to challenge

LCA as a regulatory tool

- LCA was developed as a broad analysis tool to improve understanding of production/supply chains and guide strategic decisions
- Recent legislative initiatives attempt to use LCA as a regulatory compliance tool
- A major goal-post shift which requires rethinking of all aspects of the LCA process
  - Accuracy v. Simplicity
  - Transparency
  - Verification/auditing of data
  - Burden on chain actors
  - Methodological choices
  - Use of default values
- Traditional LCA is open-ended
  - LCA for regulatory purposes must be carefully ring-fenced for practicality and consistency

LCA as a regulatory tool

Ultimate goal must remain to

- Support schemes that meet the policy objectives (e.g. GHG reduction)
- Encourage development of good practice and improvement over time

How to find the best compromise between credibility, complexity and realism?

Results translate directly into $$$

So what should Research concentrate on?

- Data: improve understanding of some key items
  - N_2O and land/agriculture
  - Soil carbon
- Indirect effects
  - Related to land use
  - Related to interactions with non-fuel sectors (e.g. co-products)
- Ability to rank impacts on the basis of materiality
  - Concentrate on most relevant items
  - Awareness of accuracy and relevance of data
- A new set of LCA rules for regulatory purposes?