JEC Biofuels and Well to Wheels Analyses

Heather Hamje
European Biofuels Technology Platform Meeting
Brussels, October 14th 2014
JEC and Evolution of Transportation Legislation

JEC Activities

- JEC Consortium formed (2000)
- WTW version 1 (2004)
- WTW version 2 (2007)
- WTW version 3 (2011) & Biofuels Study
- WTW version 4 (2013) & Biofuels update

Legislative Activities

- Clean & Energy Efficient Road Transport (2008)
- FQD and RED (2009)
- Euro 4 (2005)
- Euro 5 (2009)
- Euro 6 (2014)
- FQD/RED Reviews (2014)
- Clean Power for Transport (adopt. 2013)
- Targets for 2020+

JEC Biofuels and Well to Wheels Analyses
Flow chart applies for all vehicle types in the model: $V_{ij}$

- $i =$ Passenger Cars, Vans, HD, Busses
- $j =$ propulsion system (Diesel, Gasoline, CNG, LPG, FFV, xEV)

**Circles:** Input information  
**Rectangles:** Model calculators

- Sales,$_{i,j}$
- PT share,$_{j,i}$
- New vehicle FC,$_i$
- On-road factor,$_{i}$
- stock,$_{i,j}$
- scrappage,$_{i,j}$
- Stock size,$_{i,j}$
- stock FC,$_{i,j}$
- Fleet mileage,$_{j}$
- Fuel demand,$_{i,j}$
- Annual mileage per type,$_{j}$
- Grades / blends
- Renewable content
- Alt. Fuel availability
- FQD methodology
- GHG emission factor by fuel
- FQD GHG saving (%)
- RED-%
- RED methodology
- GHG emission factor by fuel

- 2013 update includes changes with respect to legislative initiatives, vehicle fleet, fuel and biofuel demand, and the availability of advanced biofuels

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**Fleet and Fuels Model is Heart of JEC Biofuel Study**

**Fleet and Fuels Model is Heart of JEC Biofuel Study**
Objectives of the 2013 JEC Biofuels Study:

- Clarify the opportunities and barriers to achieve 10% renewable energy in the transport sector by 2020 and a 6% reduction in GHG emissions
- Extend F&F model to test different legislative concepts for RED and FQD amendment (such as accounting caps on conventional biofuels, multiple counting factors, and GHG savings based on specific production pathways)
- Update the EU27+2 “Fleet & Fuels” model baseline from 2005 to 2010
- Update fixed demand values for non-road transport modes
- Focus on conventional and alternative fuels and biofuel blends while accounting for growth in alternative powertrains share from 2010-2020
- Update the advanced biofuel supply outlook from the bottom up
- Assess realistic biofuel implementation scenarios for 2020
Current European installed production capacity of ethanol and FAME is sufficient to cover the projected demand in 2020.

Comparison with Hart’s Energy projections shows slight differences:
- Hart’s more optimistic on E10 uptake
- JEC more optimistic on biodiesel uptake
Non-conventional biofuels: Supply Outlook

- Bottom-up approach to collect and analyse global announced projects
- Scope is bio-derived components:
  - Ligno-cellulosic Ethanol
  - Butanol
  - Methanol
  - HVO/Co-processing
  - Biomass-To-Liquid
  - DME

Main sources are:
- Hart Energy (2012); “Advanced biofuels outlook 2025”
- IEA Task 39; “Status of Advanced Biofuels Demonstration Facilities in 2012”
- NER300 projects funded by European Commission
- Additional public announced projects and Member Companies consultation

World Outlook of non-conventional biofuels in 2020 is ~9.2 Mtoe, EU is ~4.2 Mtoe
Fuel demand scenarios: background

- 4 implementation scenarios were run for the 2010-2020 time period based on
- CEN specifications for mass market fuels and vehicle compatibility outlook
- Market experience in E10 uptake (Germany, France, and Finland)

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Reference Scenario 1
E10 & E5 ‘protection grade’
B7 diesel grade

Scenario 2:
E20 introduced in 2019
E10 becomes ‘protection grade’

Scenario 3:
E10 & E5 ‘protection grade’
B7 diesel main grade
B10 diesel for HD captive fleet

Scenario 4:
Combination of Scenarios 2 & 3

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*2.5% of total HD diesel demand is B10
Higher market blend introduction can be expected to have limited impact

Introducing a new grade to the market takes time to implement

Legislative concepts explored in this 2013 study include:

- Caps on conventional biofuels applied to both RED and FQD Art. 7a, 2.5% target for advanced biofuels, and ILUC factor reporting and multiple counting factors for feedstocks and/or fuels
Comparison legislative concepts: Results

<table>
<thead>
<tr>
<th>For Reference Scenario</th>
<th>RED</th>
<th>FQD [w/o ILUC]</th>
<th>FQD [w/ ILUC]</th>
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<tbody>
<tr>
<td>TARGET</td>
<td>10%</td>
<td>6%</td>
<td>NA</td>
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<td>2011 JEC Biofuel Study</td>
<td>2009 RED &amp; FQD</td>
<td>9.7%</td>
<td>4.4%</td>
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| 2013 JEC Biofuel Study | 2009 RED & FQD | 8.7% | 4.3% | NA |
|                        | 2012 EC Proposal | 7.8% | 4.3% | 1.0%¹ |
|                        | 2013 EP 1st Reading | 8.2% | NA | 1.0% |
|                        | 2013 Council Text | 8.7% | 4.3% | 1.0%¹ |

1) ILUC reporting only

- 2011 study indicated that RED and FQD 2020 targets were not likely to be met
- The 2013 Biofuels Study results conclude that achieving the 2020 targets is now less likely compared to the 2011 assessment
- Older vehicles, slower uptake of E10 than expected, advanced biofuels uncertain
Well to Wheels study and Objectives

- A Well-to-Wheels analysis is the essential basis to assess the impact of future fuel and powertrain options.
- Both fuel production pathway and powertrain efficiency are impacting the GHG emissions as well as total and fossil energy use.
- A common methodology and data-set has been developed providing a basis for the evaluation of pathways.
  - Including biofuels as well as other alternative fuels
- Objectives were to establish, in a transparent and objective manner, a consensual Well-to-Wheels evaluation of
  - energy use and GHG emissions
  - wide range of automotive fuels and powertrains relevant to Europe in 2020 and beyond
- To have the outcome accepted as a reference by all relevant stakeholders.
Well-to-Wheels “Pathway” for Fossil Fuels

Well

- Produce primary fuel
- Transport primary fuel

Well-to-Tank (WTT)

- Produce road fuel
- Distribute road fuel

Well-to-Tank (WTT)

- Fuel vehicle

Tank-to-Wheels (TTW)

- Burn fuel in vehicle

Wheels

Similar pathways can be calculated for alternative fuels.
For each “WTW” pathway calculate:
- Total energy required
- Total GHG intensity

Source: Conventional vehicles and fuels: JEC Well to Wheels Study (2005)
Scope of Tank to Wheels

- Define and characterize reference vehicle & vehicle technologies
  - Generic C-segment vehicles (e.g. VW Golf, Ford Focus, PSA 307)
- All vehicles are based on same reference for comparability
  - All vehicles share same glider as reference (body & chassis)
  - Alternative vehicles are defined by virtually removing and adding specific components
  - Weight impact of tanks, extra batteries, etc. is covered
- New European Driving Cycle (NEDC) & UNECE R101 applied
- Fuel consumption & electric energy consumption
- GHG emissions: CO$_2$, CH$_4$ & N$_2$O
- Comprehensive vehicle simulations with AVL Cruise
  - Data, calibrations, controls, etc. agreed amongst the EUCAR and AVL expert team
- Timeline: 2010 & 2020+
### Well-to-Wheels Pathways included in WTW4

#### Resource
- Crude oil
- Coal
- Natural Gas
- Shale Gas
- Biomass
- Wind
- Nuclear
- Electricity

#### Fuels
- Conventional
  - Gasoline/Diesel/Naphtha
- Synthetic Diesel
- CNG, CBG, SNG
- LPG
- MTBE/ETBE
- Hydrogen (compressed / cryo-compressed)
- DME
- Ethanol
- Bio-diesel (inc. FAEE)
- HVO
- Electricity

#### Powertrains
- Spark Ignition:
  - Gasoline, LPG, CNG, CBG, SNG, Ethanol
- Compression Ignition:
  - Diesel, DME, Bio-diesel
- Fuel Cell
- xEVs:
  - HEV, PHEV, REEV, BEV

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JEC Biofuels and Well to Wheels Analyses
Net GHG emissions from production of bio-ethanol depend critically on:

- The technology and energy source used
- The disposition of the co-products

Ethanol from sugar cane or cellulosic materials (wood or straw) produces lower emissions than ethanol from wheat.
GHG emissions for bio-diesel depend on the feedstock
- Waste oils and tallow have the lowest emissions, because emissions from feedstock production are avoided.

Co-product disposition plays a role but less so than with bio-ethanol
- Good practice can reduce emissions significantly
WTW energy expended and GHG emissions for some biofuel pathways (2020+ vehicles)
Conclusions

- **2011 Biofuels Study** suggested that RED and FQD 2020 targets will **not** be met.
- The **2013 Biofuels Study results** conclude that achieving the 2020 targets is now **less likely** compared to the 2011 assessment.
- A **Well-to-Wheels** analysis is the **essential basis** to assess the impact of future fuel and powertrain options.
- A **common methodology** and **data-set** has been developed providing a basis for the **evaluation of pathways** which can be updated as technologies evolve.
- An **integrated approach** across all energy using sectors is essential to reduce energy consumption and GHG emissions most effectively.
- A **shift to renewable/low-carbon routes** may offer a **significant GHG reduction** potential **but generally requires more total energy**.
- The specific pathway is critical.
Thank You For Your Attention!

The reports discussed in this presentation are available on the WEB:

http://iet.jrc.ec.europa.eu/about-jec

For questions / inquiries / requests / notes to the JEC Consortium,
please use the centralised mail address:

infoJEC@jrc.ec.europa.eu