European Commission

J R C T E C H N I C A L R E P O R T S

WELL-TO-TANK Appendix 4 - Version 4a

Description, results and input data per pathway

WELL-TO-WHEELS ANALYSIS OF FUTURE AUTOMOTIVE FUELS AND POWERTRAINS IN THE EUROPEAN CONTEXT

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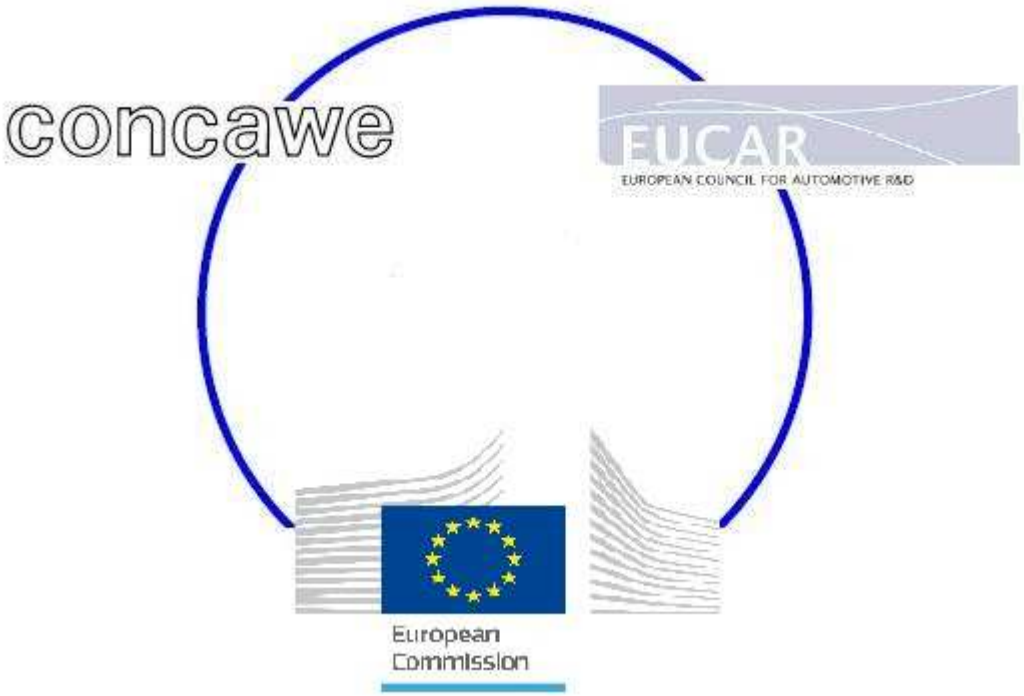

WELL-TO-TANK (WTT) REPORT – APPENDIX 4

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This report is available as an ADOBE pdf file on the JRC/IET website at:

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Questions and remarks may be sent to:

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Description, results and input data per pathway

This appendix contains nine workbooks presenting the details of each pathway. Every workbook follows a common template that includes the following elements:

Content of the workbook
An easy to use navigation section that guide you through the workbook with links to the different pathways. A short description per pathway is given.

Summary of the results
Summary of Expended energy and GHG emissions for each pathways including graphs.

General notes
Notes applicable to all pathways in the workbook.

Individual pathway results and input data
Detailed results for each pathway, comparison between JEC and RED methodology where applicable, stepwise description of input data including figures, references and narrative.

Notes

A number of pathways have been evaluated but are not carried forward to the WTW stage. They are not described in full detail here but overall results are given for reference.

In the results section the energy and GHG emission figures are expressed per MJ of the final fuel. However, the input data is generally expressed per MJ of the output product of the particular process or step (e.g. the energy required for wheat farming is shown per MJ of wheat grain, rather than MJ of ethanol).

The energy figures are expressed as net total primary energy expended (i.e. *excluding* the energy transferred to the final fuel). Where fuels or intermediate energy sources (e.g. electricity) are used the total primary energy is allocated to the pathway including the energy necessary to make the fuel or the electricity.

Examples:

- 1 MJ of fossil diesel fuel requires 1.2 MJ of primary energy, of which 1 MJ is contained in the final diesel fuel itself. The expended energy is thus 0.2 MJ per MJ diesel fuel.
- 1MJ of electricity generated with an efficiency of 33% will results in 3 MJ of primary expended energy.

All energy is accounted for regardless of the primary energy source, i.e. including renewable energy. This is necessary to estimate the energy footprint of each process and each pathway. The shares of fossil, nuclear and renewable energy in each complete pathway are shown in the overall pathway energy balance.

The CO_2 figures represent the net emissions relating to the pathway i.e. excluding CO_2 emitted when burning biomass.

The figures used in this study and described in this appendix are generally based on literature references as given. In a number of cases we have used figures from unpublished work by one of the JEC partners (these are indicated as “internal”. Where no specific reference is given, the figures are the result of standard physical calculations based on typical parameters. This is the case for instance for CNG or hydrogen compression energy.

Where appropriate we have specified a range of variability associated with a probability distribution either normal (Gaussian), double-triangle for asymmetrical distribution or equal (all

values in the range equally probable). The equal distribution has been used when representing situations where a range of technologies or local circumstances may apply, all being equally plausible. For the complete pathway, a variability range is estimated by combining the individual ranges and probability distributions with the Monte-Carlo method.

1 Oil and gas

WTT v4a pathways
1-Oil & Gas rep.xlsx

2 Biogas and Synthetic Methane

WTT v4a pathways
2-CBG rep.xlsx

3 Ethanol

WTT v4a pathways
3-Ethanol rep.xlsx

4 Biodiesel

WTT v4a pathways
4-Biodiesel rep.xlsx

5 Synfuels

WTT v4a pathways
5-Synfuels rep.xlsx

6 Electricity

WTT v4a pathways
6-Electricity rep.xlsx

7 Heat & Power

WTT v4a pathways
7-Heat & Power rep.›

8 Hydrogen (thermal)

WTT v4a pathways
8-H2 rep.xlsx

9 Hydrogen (electrolysis)

WTT v4a pathways
9-Electrolysis rep.xls›

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Abstract

The Well-to-Tank study describes the process of producing, transporting, manufacturing and distributing a number of fuels suitable for road transport powertrains. It covers all steps from extracting, capturing or growing the primary energy carrier to refuelling the vehicles with the finished fuel.
This Appendix 4 contains nine workbooks presenting the details of each pathway.
This Version 4.a replaces Version 4.0 [Report EUR 26028 EN] published in 2013

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