

JRC TECHNICAL REPORTS

WELL-TO-TANK Appendix 4 - Version 4a

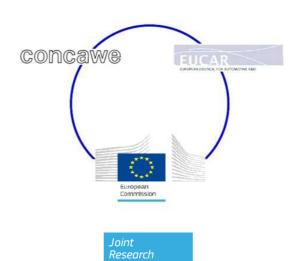
Description, results and input data per pathway

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

Authors: Robert EDWARDS (JRC), Jean-François LARIVÉ (CONCAWE), David RICKEARD (CONCAWE), Werner WEINDORF (LBST)

Editors: Simon Godwin (EUCAR), Heinz Hass (Ford/EUCAR), Alois Krasenbrink (JRC), Laura Lonza (JRC), Heiko Maas (Ford), Robin Nelson (CONCAWE), Alan Reid (CONCAWE), Kenneth D. Rose (CONCAWE)

2014



Report EUR 26237 EN

European Commission Joint Research Centre Institute for Energy and Transport

Contact information Laura Lonza Address: Joint Research Centre, Via Enrico Fermi 2749, TP 230, 21027 Ispra (VA), Italy E-mail: laura.lonza@ec.europa.eu Tel.: +39 0332 78 3902 Fax: +39 0332 78 6671

http://iet.jrc.ec.europa.eu/ http://www.jrc.ec.europa.eu/

This publication is a Technical Report by the Joint Research Centre of the European Commission.

Legal Notice

This publication is a Technical Report by the Joint Research Centre, the European Commission's in-house science service.

It aims to provide evidence-based scientific support to the European policy-making process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

JRC85326

EUR 26237 EN

ISBN 978-92-79-33888-5 (pdf)

ISSN 1831-9424 (online)

doi:10.2790/95629

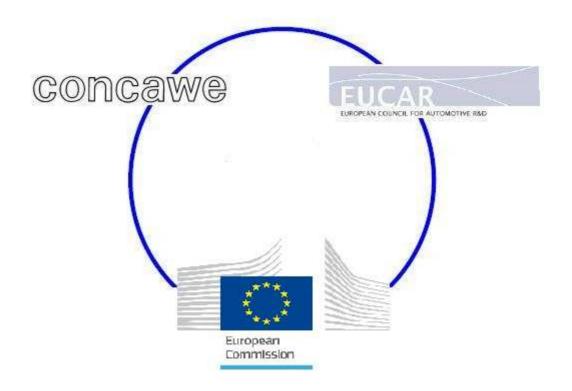
Luxembourg: Publications Office of the European Union, 2014

© European Union, 2014

Reproduction is authorised provided the source is acknowledged.

Printed in Italy

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



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

Version 4a, APRIL 2014

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

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

Questions and remarks may be sent to:

infoJEC@jrc.ec.europa.eu

Notes on version number:

This is version 4a of this report replacing version 4 published in July 2013.

Acknowledgments

This JEC Consortium study was carried out jointly by experts from the JRC (EU Commission's Joint Research Centre), EUCAR (the European Council for Automotive R&D), and CONCAWE (the oil companies' European association for environment, health and safety in refining and distribution), assisted by experts from Ludwig-Bölkow-Systemtechnik GmbH (LBST) and AVL List GmbH (AVL).

Main Authors, Well-to-Tank (WTT) Report

R. Edwards	JRC
J-F. Larivé	CONCAWE
D. Rickeard	CONCAWE
W. Weindorf	LBST

JEC Scientific Advisory Board

JRC
EUCAR
EUCAR/Ford
JRC
JRC
EUCAR/Ford
CONCAWE
CONCAWE
CONCAWE
CONCAWE

JRC Task Force

A. Agostini	JRC
R. Edwards	JRC
J. Giuntoli	JRC
M. Kousoulidou	JRC
L. Lonza	JRC
A. Moro	JRC
M. Padella	JRC

EUCAR Task Force

T. Becker V. Boch B. Bossdorf-Zimmer H-P. Deeg V. Formanski T. Galovic A. Gerini H. Hass F. Herb E. Iverfeldt L. Jacobs J. Klemmer H. Mass B. Moeller B. Perrier W. Prestl J. Rizzon A. Roj	Opel Renault VW Porsche Opel BMW Fiat Ford Daimler Scania Volvo Opel Ford Daimler PSA BMW Daimler Volvo

CONCAWE Task Force

F. Bernard	TOTAL
S. Boreux	TOTAL
V. Court	CONCAWE
C. Diaz Garcia	Repsol
J. Farenback-Bratema	an ExxonMobil
S. Kuusisto	Neste Oil
J-F. Larivé	CONCAWE
R. Malpas	Shell
E. Marin	Repsol
C. Olivares Molina	CEPSA
C. Price	Shell
A. Rankine	BP
A. Reid	CONCAWE
D. Rickeard	CONCAWE
K. Rose	CONCAWE
T. Venderbosch	CONCAWE
H. Hamje	CONCAWE

LBST (Well-to-Tank Consultant) W. Weindorf

AVL Consultants

AVE CO

- R. Albrecht
- E. Morra

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



Ethanol

3



WTT v4a pathways 3-Ethanol rep.xlsx

4 Biodiesel



WTT v4a pathways 4-Biodiesel rep.xlsx



WTT v4a pathways 5-Synfuels rep.xlsx

6 Electricity



7 Heat & Power



WTT v4a pathways 7-Heat & Power rep.>

8 Hydrogen (thermal)



9 Hydrogen (electrolysis)



WTT v4a pathways 9-Electrolysis rep.xls>

Europe Direct is a service to help you find answers to your questions about the European Union Freephone number (*): 00 800 6 7 8 9 10 11 (*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet. It can be accessed through the Europa server http://europa.eu/.

How to obtain EU publications

Our priced publications are available from EU Bookshop (http://bookshop.europa.eu), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.

European Commission EUR 26237 – Joint Research Centre – Institute for Energy and Transport

Title: WELL-TO-TANK Appendix 4 - Version 4.a. Description, results and input data per pathway.

Author(s): Robert EDWARDS (JRC), Jean-François LARIVÉ (CONCAWE), David RICKEARD (CONCAWE), Werner WEINDORF (LBST) Luxembourg: Publications Office of the European Union

2014 – 10 pp. – 21.0 x 29.7 cm

EUR - Scientific and Technical Research series - ISSN 1831-9424 (online)

ISBN 978-92-79-33888-5 (pdf)

doi:10.2790/95629

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

JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society Stimulating innovation Supporting legislation



DOI 10.2790/95629 ISBN 978-92-79-33888-5