GREEN EFFORTS

Green and Effective Operations at Terminals and in Ports

FP7-285687

Deliverable 5.4

Report on modelling of energy consumption

Organisation name of lead contractor for this deliverable: Fraunhofer CML

Due date of deliverable: [31/06/2014]
Actual submission date: [02/09/2014]

Call (part) identifier: FP7-SST-2011-RTD-1
Funding Scheme: Collaborative Project
Start date of project: 01/01/2012 Duration: 30 months

Revision: final

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

DOCUMENT INFORMATION

D 5.4

Report on modelling of energy consumption

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Issuing entity:	FRAUNHOFER CML
Document Code:	2014 09 02 GREEN EFFORTS D5.4 REPORT ON MODELLING OF ENERGY CONSUMPTION
Date of Issue:	02/09/2014
Status:	Final
Revision:	0
Contributing Partners / Authors	FRAUNHOFER CML / REINER BUHL, JUB
Pages	4
Figures	0
Tables	0
Annexes	0

RECORD OF CHANGES

This is a controlled document for any changes and amendments done for the deliverable.

Amendment shall be by whole document replacement.

Version	Status	Date	Authorized by
0.1	Draft version – Consortium review	31.07.2014	
1.0	Final version	02.09.2014	

TABLE OF CONTENTS

Executive summary

Different approaches on simulating terminals have been presented and evaluated in D5.1 and a meso-simulation approach seemed most favourable. This simulation approach was foreseen to be implemented using the mathematical programming software R.

In D5.2, three micro simulation models of port terminals were developed in the Software Enterprise Dynamics Developer to answer several questions of importance for the RoRo Port of Trelleborg, an example RTG Container terminal and for an inland container terminal. For the existing ports, advice was given for future port development decisions. In all models, measures to ensure validity were carried out.

D5.3 was structured to assess possibilities to improve container terminal operations by linking simulation with terminal operation system software (TOS). Most TOS providers' responses, however, are quite cautious as they consider their products as highly confidential and do not disclose their algorithms to external parties. Therefore, theoretical considerations where made on how to improve TOS Software regarding decreased energy consumption and respective lower emissions on terminals: One possible solution is to document energy consumption and use statistically conditioned data from the past to improve future decisions.

1 Introduction

In this deliverable, all prior deliverables of work package 5 will be recalled with their claims, approaches and results separately in section 2, 3 and 4. For every section, a passage follows as ex-post view on the deliverables. Finally, knowledge and experience gained in all tasks of work package 5 will be reassessed in the conclusion.

2 D5.1 Methodology & Tools

Different approaches on simulating terminals have been presented and evaluated in D5.1. Special attention has been paid to the project's objectives and the chosen research methods ability to cover those. Precautious considerations have been made regarding the models output / scope and the usability for extensive testing. At this point a meso-simulation approach seemed most favourable, since it balances level of detail with computability. This simulation approach was foreseen to be implemented using the mathematical programming software R. It is widely accepted in the scientific community, freely available and the parallel-processing capabilities allow for large scale testing.

3 D5.2 Simulation Models & Simulation Results

For Simulation, the Software Enterprise Dynamics Developer was used despite of the proposed decision of D5.1. The reason is that ED is widely used in the industry and developing models in ED is more economic than the option proposed in D5.1. In task 5.2, three micro-simulation models of port terminals were developed to answer different questions which are relevant for the industry: First, for the RoRo Port of Trelleborg, the amount of carbon dioxide emissions produced by external vehicles in ferry port was determined. Second, the best dispatching strategy for horizontal transport and respective vehicle configuration was identified weighing financial, operational and environmental criteria against each other for a non-existing example RTG Container terminal. In this case, significant saving or wasting potential was identified. Third, for an inland container terminal with restricted pre gate area the amount of container trucks that can be handled per hour was determined. For the existing ports, recommendations are provided for future port development decisions. To enhance validity, several trace analyses were conducted during the modelling processes to lower the probability of errors. Finally, visualisation helps to track the behaviour of the simulation model during experiments. For the RoRo Port, real numbers could be compared to improve the validity.

4 D5.3 Feasibility Study

A large fraction of energy consumption of port terminals is caused by transport of goods on terminal premises. (Energy consumption on terminals is assessed in GREEN EFFORTS Work Package 4 and documented in the corresponding Deliverables.) For this reason, the challenge is to assess how the management and control of internal transport and other controllable processes by Terminal Operating Systems (TOS) can influence energy consumption. The consequential research question with regards to this Work Package 5 is:

How can energy efficiency be improved and emissions be decreased in terminal operation by means of simulation?

Feasibility study was structured to assess possibilities to improve container terminal operations by linking simulation with terminal operation system software (TOS). Most TOS providers' responses, however, are quite cautious as they consider their products as highly confidential and do not disclose their algorithms to external parties. Theoretical considerations where made on how to improve TOS Software regarding their potential to decrease energy consumption and respective emissions: One possible, which is not spread in current TOS is to document energy consumption and use statistically conditioned data from the past to improve future decisions.

The GREEN EFFORTS project proposes that TOS providers include modules for documentation of energy consumption and related operational measures like travel distances of container handling equipment into their TOS. This data could be used for ex post assessment and improvement of decisions as well as computerized optimization approaches. This approach could contribute to productive but at the same time energy efficient and low emission terminal operation.

5 Conclusion

5.1 Simulation tool and method

As explained in section 3, the simulation method and tool selected in task 5.2 are not in line with the decisions made in D 5.1. Instead of the proposed meso-simulation programmed in R, micro-simulation models were developed using the software Enterprise Dynamics Developer 8.5.2 (ED) and partly using the "Trans Sim Node Library". The reason was the wide spread usage of ED in the industry and estimated lower effort to develop models.

5.2 Energy Consumption and resulting Emissions

Using simulation, relevant questions of GREEN EFFORTS industry partners were answered. For the RTG container terminal model results, significant waste or saving potential was identified due to choosing the right dispatching rules and vehicles. For the RoRo terminal of Trelleborg, the average value of CO_2-emissions produced by

external road vehicles using the port was determined as basic comparison scenario, which can be compared to future scenarios.

Over all tasks in work package 5 it could be shown that with various measures, also with improved TOS software, energy consumption and resulting emissions can be reduced in port terminals.