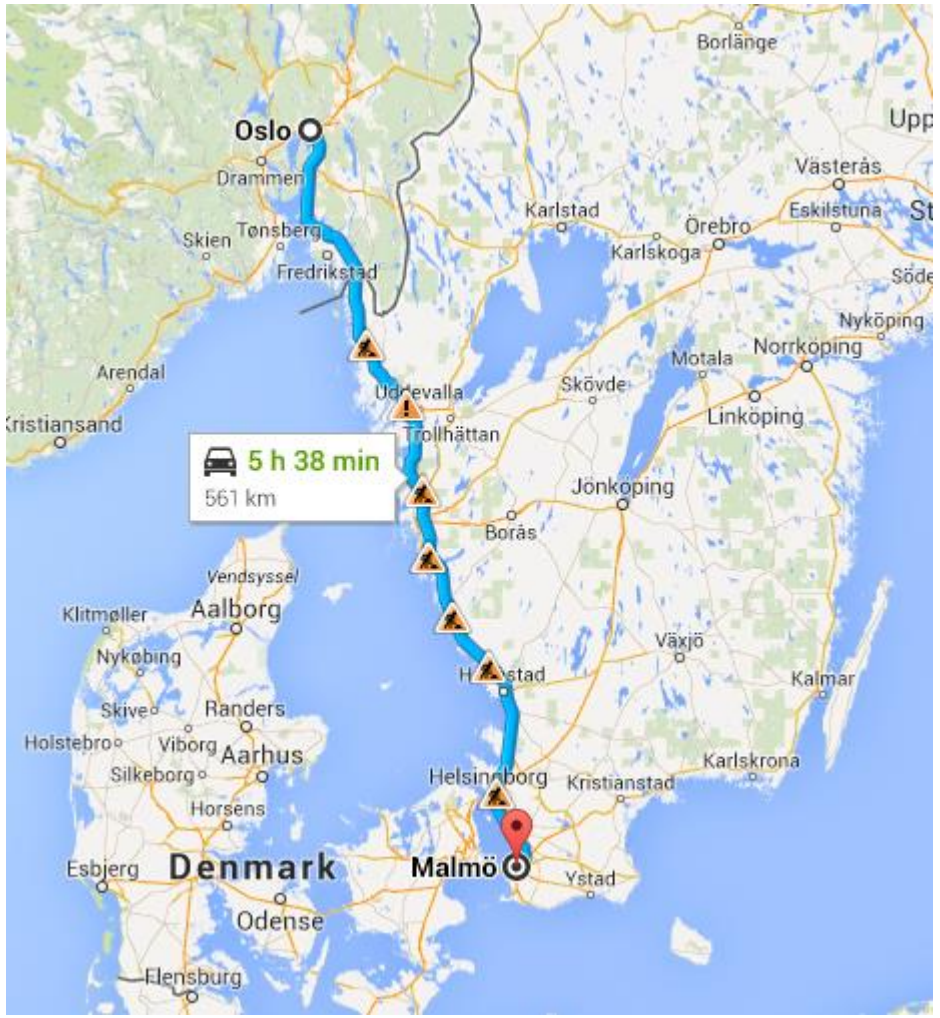
Vehicle Productivity

Need, definition and analysis

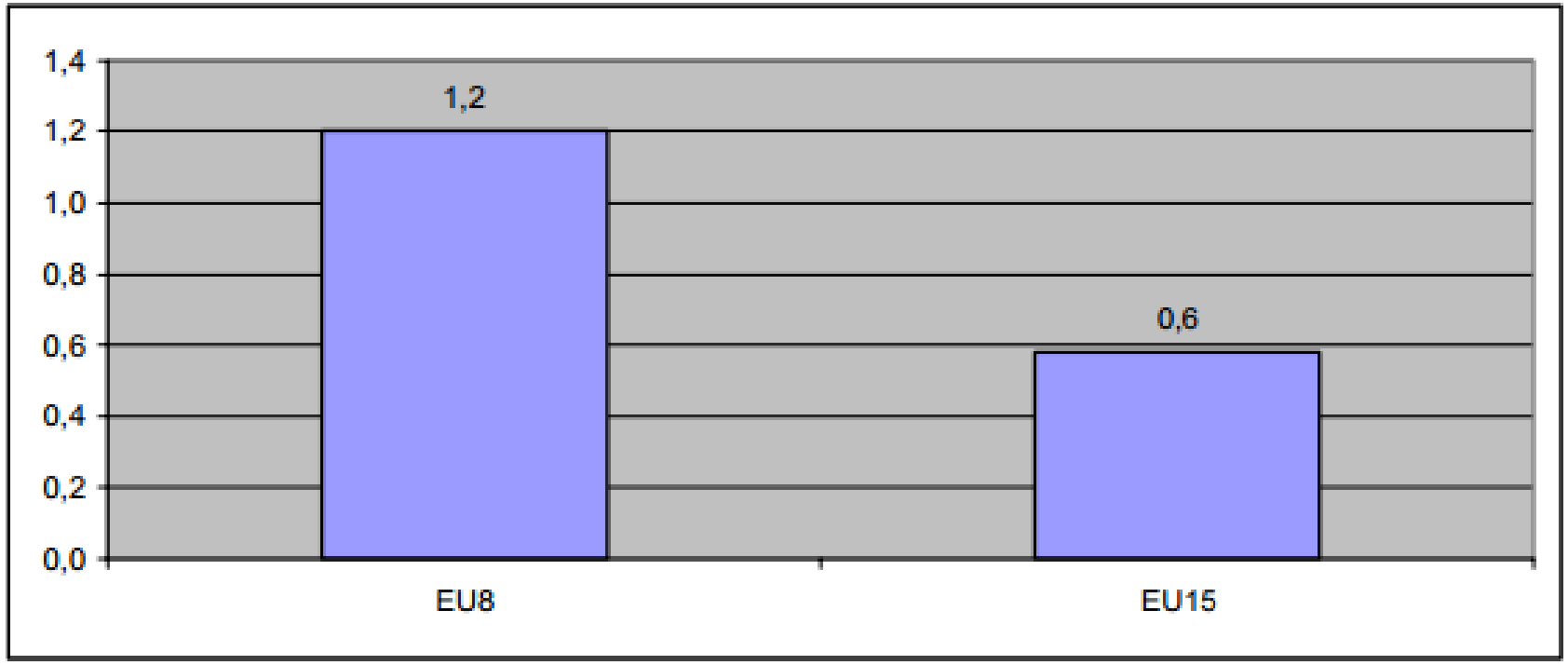
Presentation Outline

- Background
- Product Offering (POF) evaluation today
- Inadequacy of current measure
- Vehicle Productivity
- Mathematical formulation
- Analysis
- Conclusions / Thoughts
- Questions

Right Product for the Mission



How do haulers perform today?

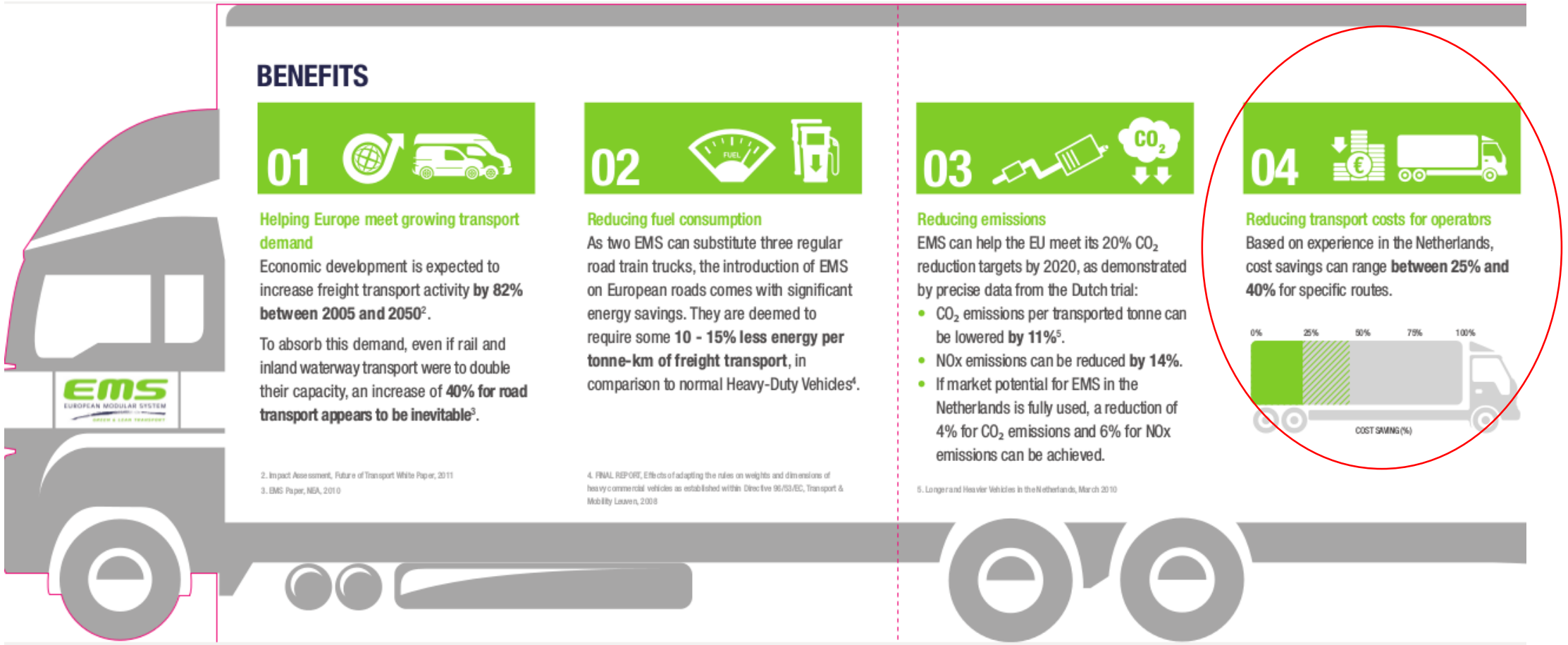


Source: Questionnaire among IRU member associations

Percentage of total turnover (EU8 and EU15)

http://www.iru-eapd.org/detail_publications/id.101

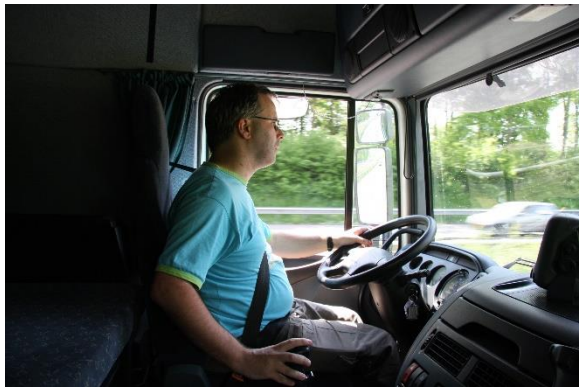
Long Combinations



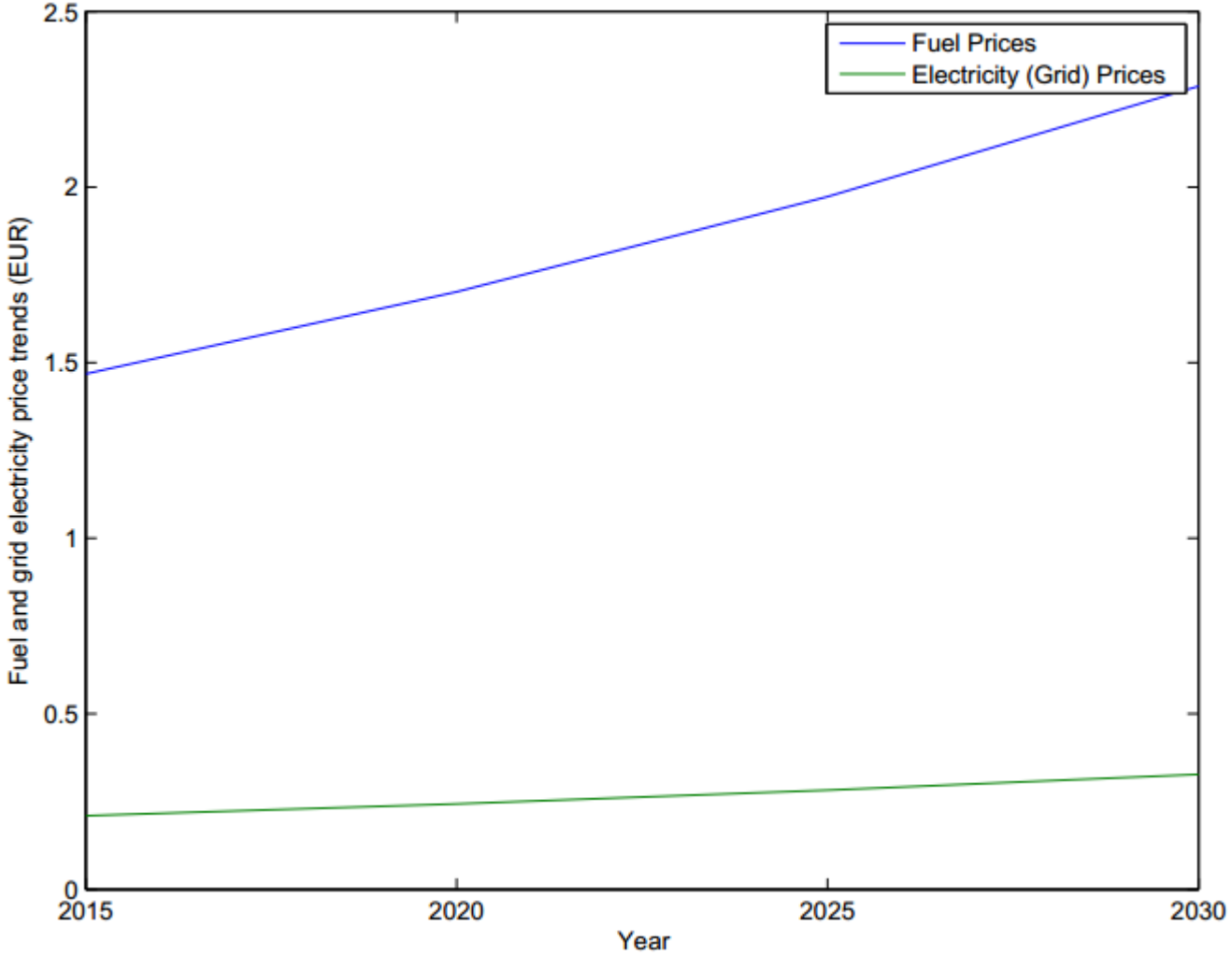
EMS Forum Brochure on European Modular Systems. Nov. 2013.

Transport Costs / TCO

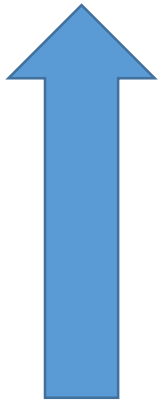
TCO



Component trends – Fuel & Electricity Prices

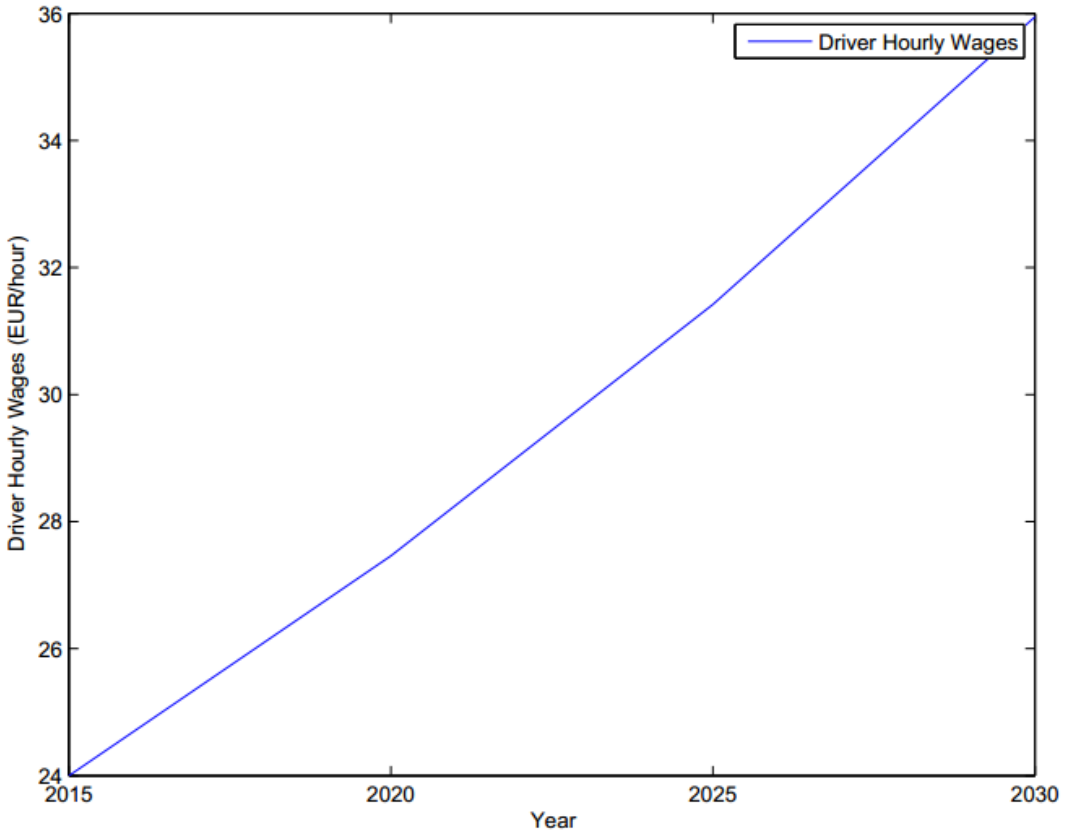


+ 3% YoY



Eurostat. Energy price statistics. 2014. url: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Energy_price_statistics (visited on 08/28/2014)

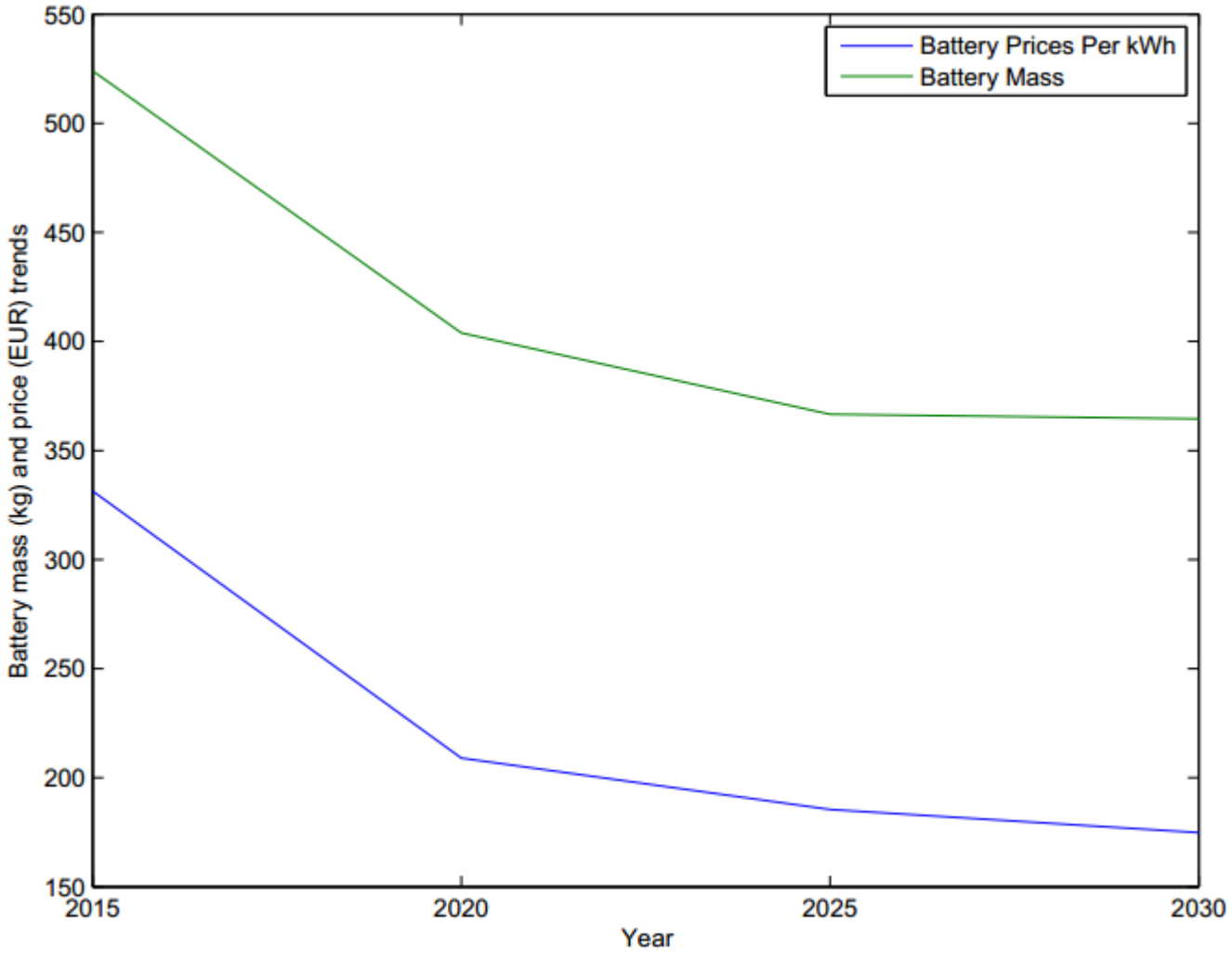
Component Trends – Driver Wages



+ 3% YoY

Collection and Analysis of Data on the Structure of the Road Haulage Sector in the European Union. Tech. rep. ENER/C3/413-2010. AECOM House 179 Moss Lane, Altrincham, WA15 8FH: AECOM Ltd., 2014

Component Trends – Batteries (5-100 kWh)



-45%

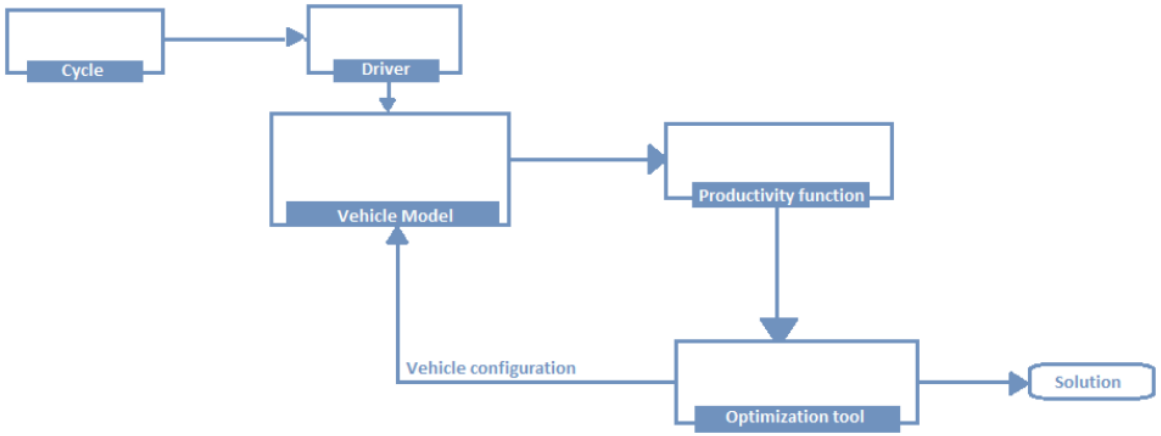
Battery Prices Per kWh

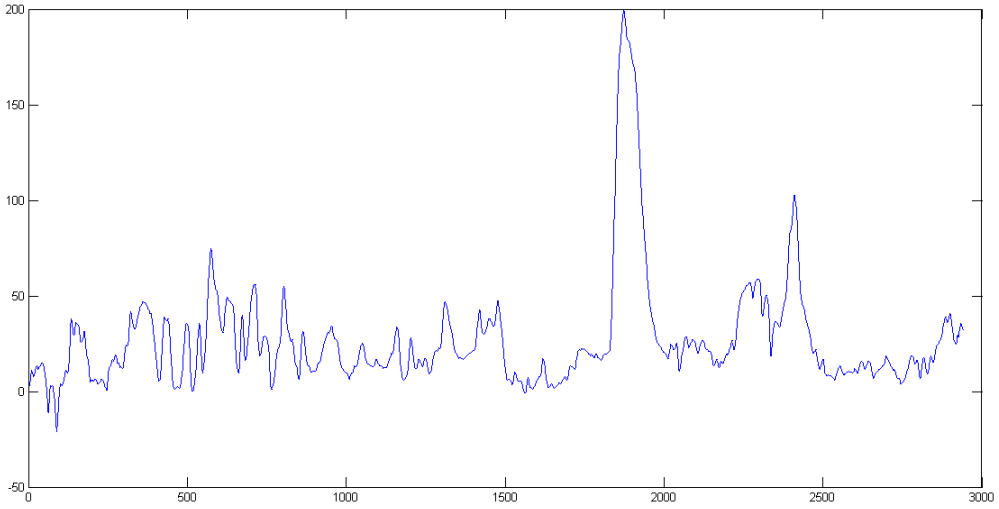
-30%

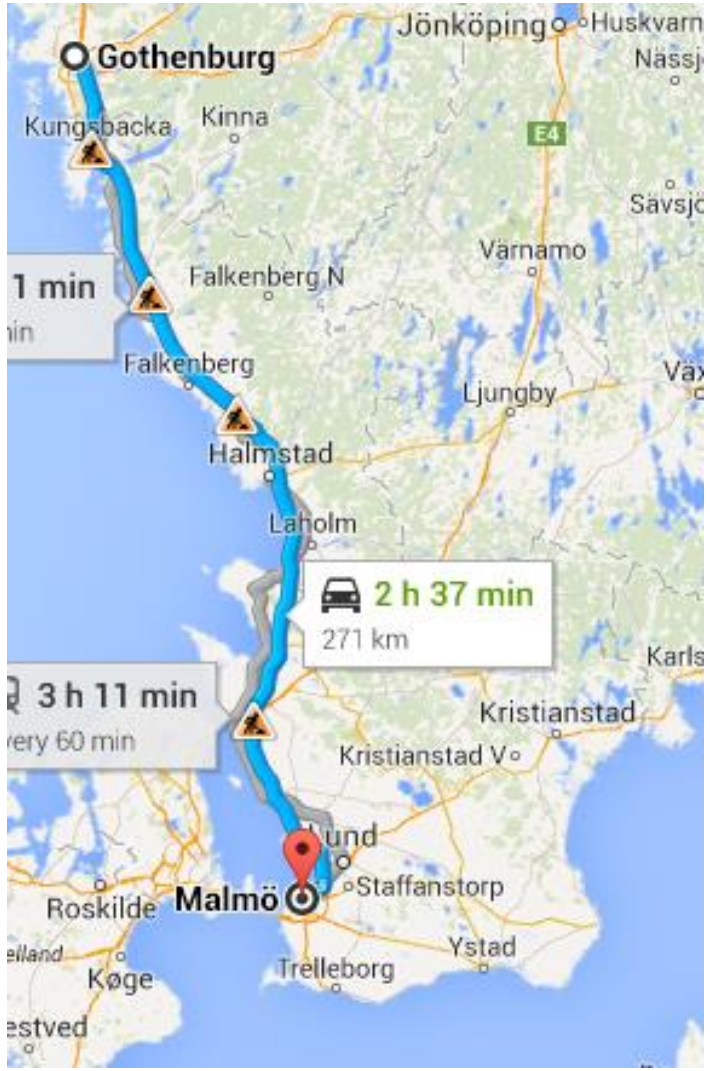
Battery Mass (50kWh)

A Review of Battery Technologies for Automotive Applications. Tech. rep. EUROBAT, ACEA, JAMA, KAMA and ILA, 2013

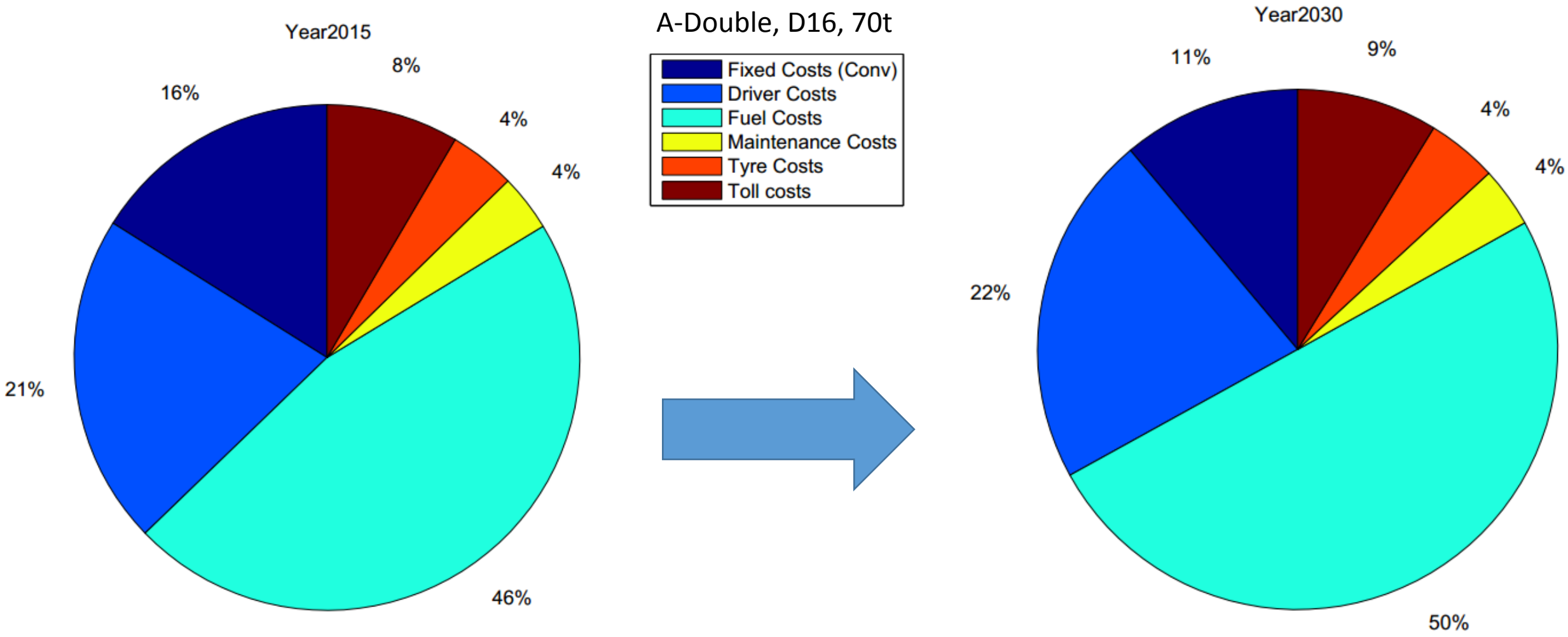
Simulation based TCO generation



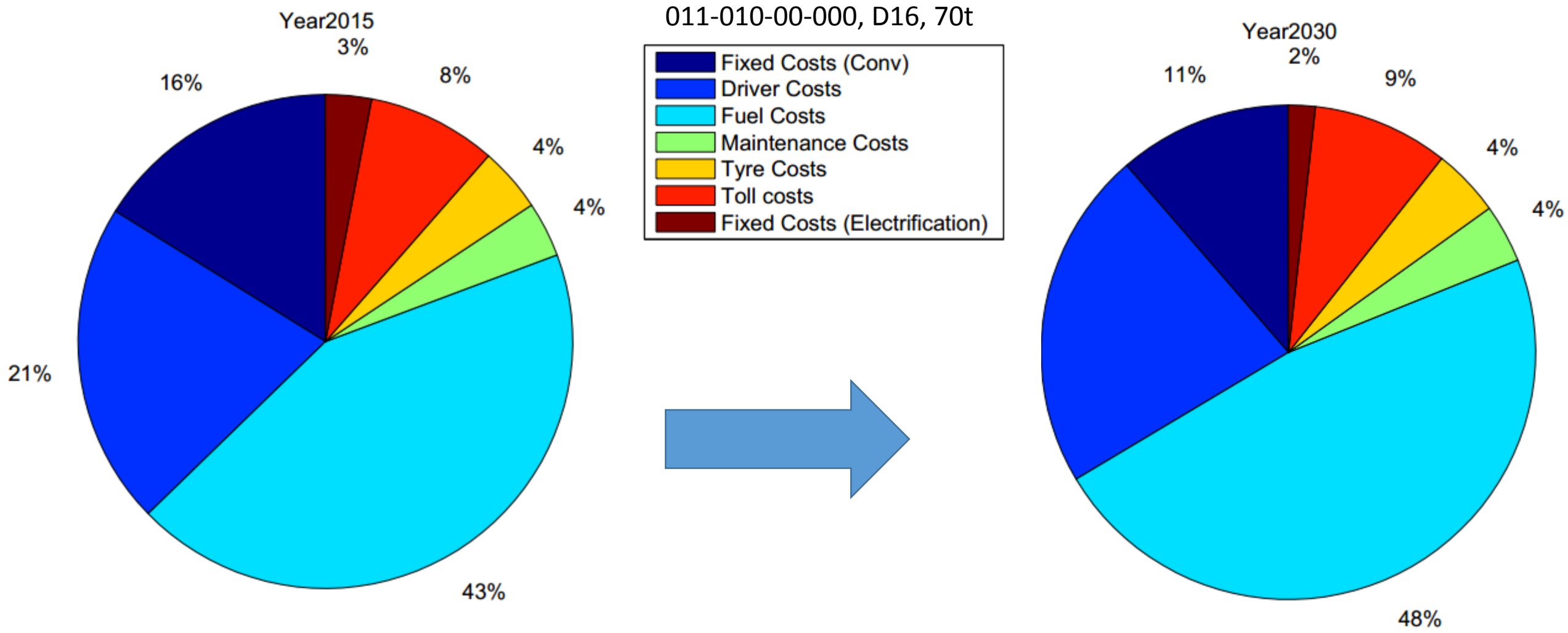




Trends in Component Costs for the Mission

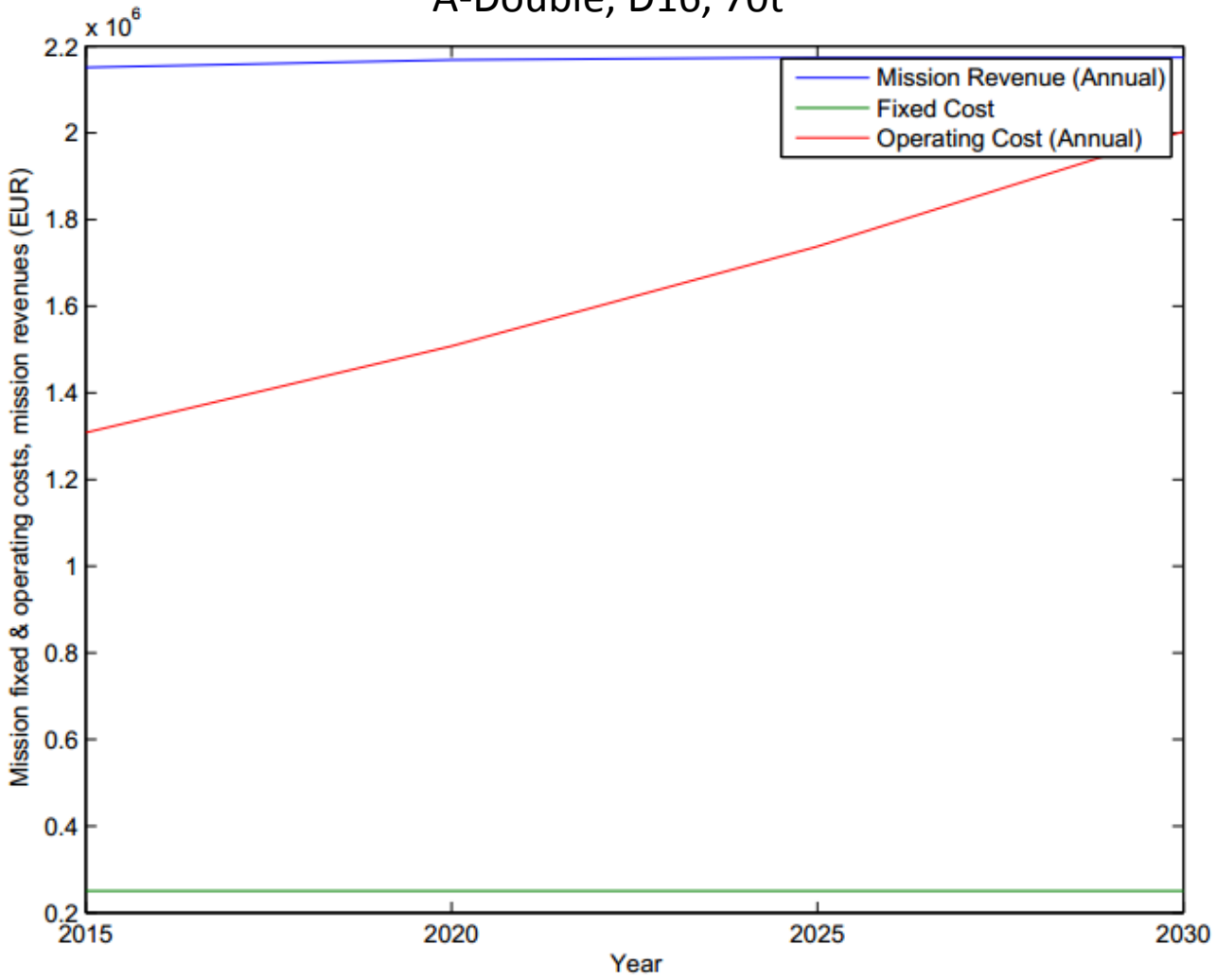


Trends in Component Costs for the Mission

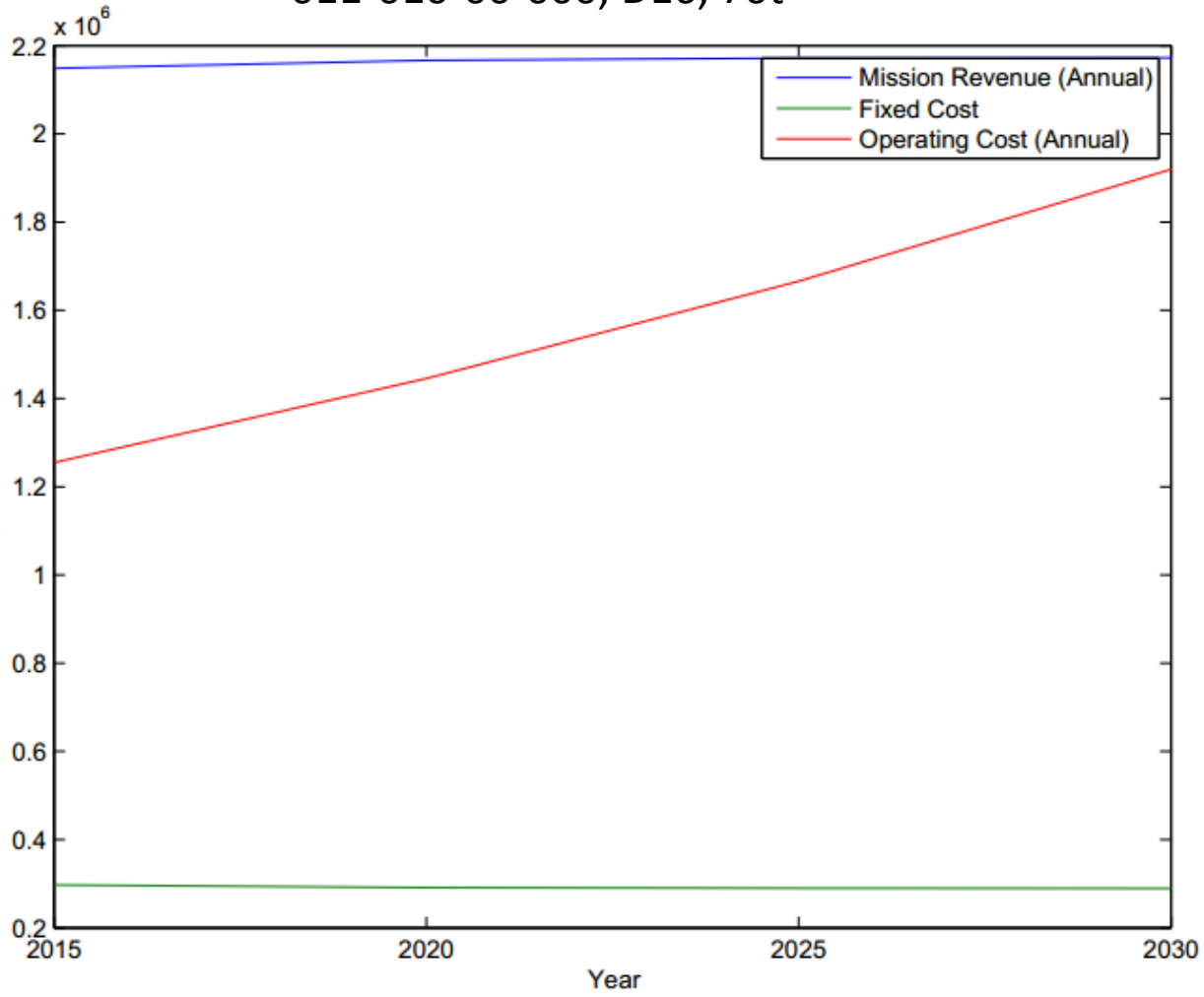


Absolute trends in TCO

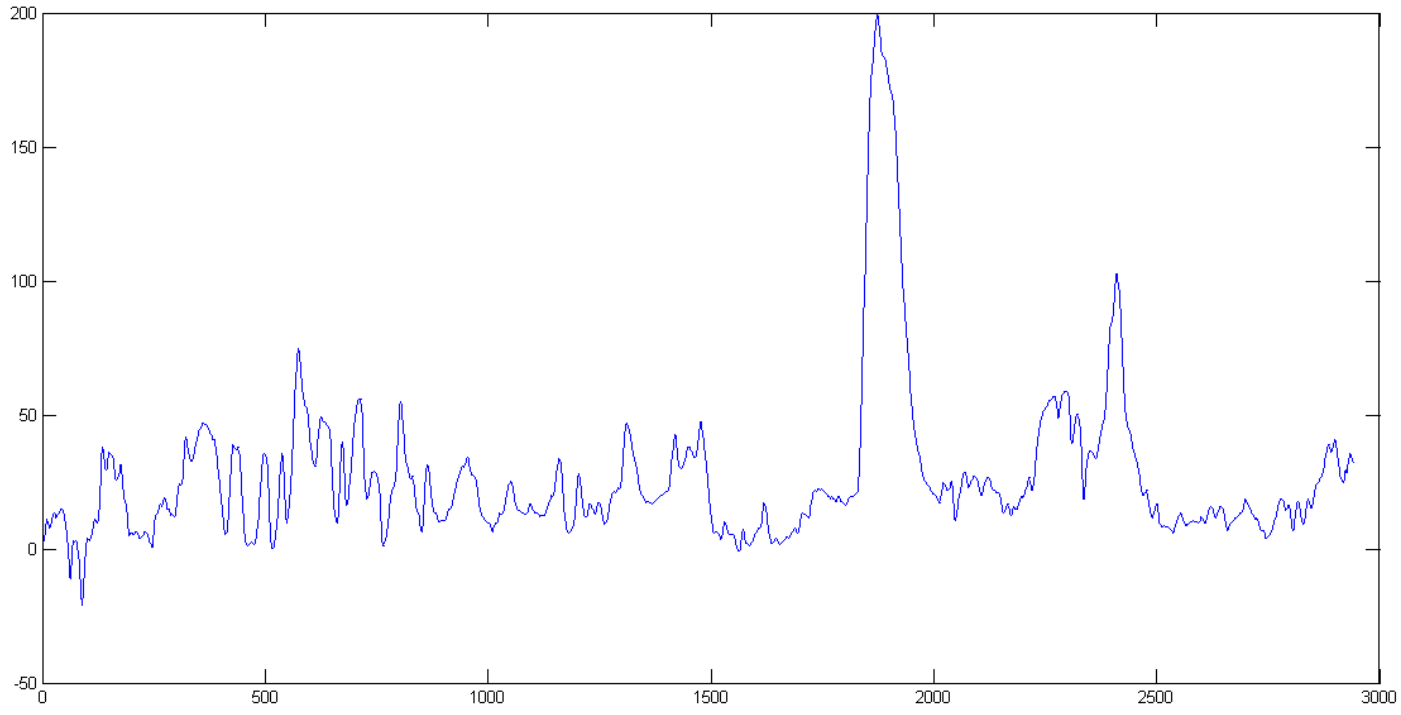
A-Double, D16, 70t



011-010-00-000, D16, 70t



Right Product for the Mission?



Vehicle Productivity

- Outputs per unit Input
- Single / multi factor
- Examples
- Why multifactor?

Vehicle type	Fuel consumption rate			
	Per VKT		Per TKM	
	1971	2007	1971	2007
LCVs	12.8	12.8	108.7	60.7
Rigid trucks	23.3	26.0	12.7	7.2
Articulated trucks	45.7	49.5	4.7	2.7
All CVs	27.9	36.4	8.1	3.5
All HVs	19.9	19.8	11.8	6.2

MF-Vehicle Productivity

$$\frac{Revenue_{annual} \times N_{first\ owner}}{Cost_{fixed} + Cost_{variable}}\ €/€$$

$$R_{mission} = R_{unit\ freight} \times M_{payload,\ net} \times D_{mission}\ €/mission$$

$$R_{annual} = R_{mission} \times N_{mission,\ annual}\ €/year$$

$$C_{fixed} = C_{fixed,\ conv} + \sum_{i=2}^{N_{units}} C_{fixed,\ elec,i}$$

$$C_{variable,\ mission} = C_{driver} + C_{fuel} + C_{mnt} + C_{tyres} + C_{tolls} + C_{elec}$$

Vehicle utilisation

$$U = \frac{M_{payload,\ gross}}{M_{axle,max}}\ (Tonnage - limited)$$

$$U = \frac{V_{payload,\ gross}}{V_{payload,\ max}}\ (Volume - limited)$$

$$R_{annual,\ corrected} = R_{annual} \times \frac{1}{U}$$

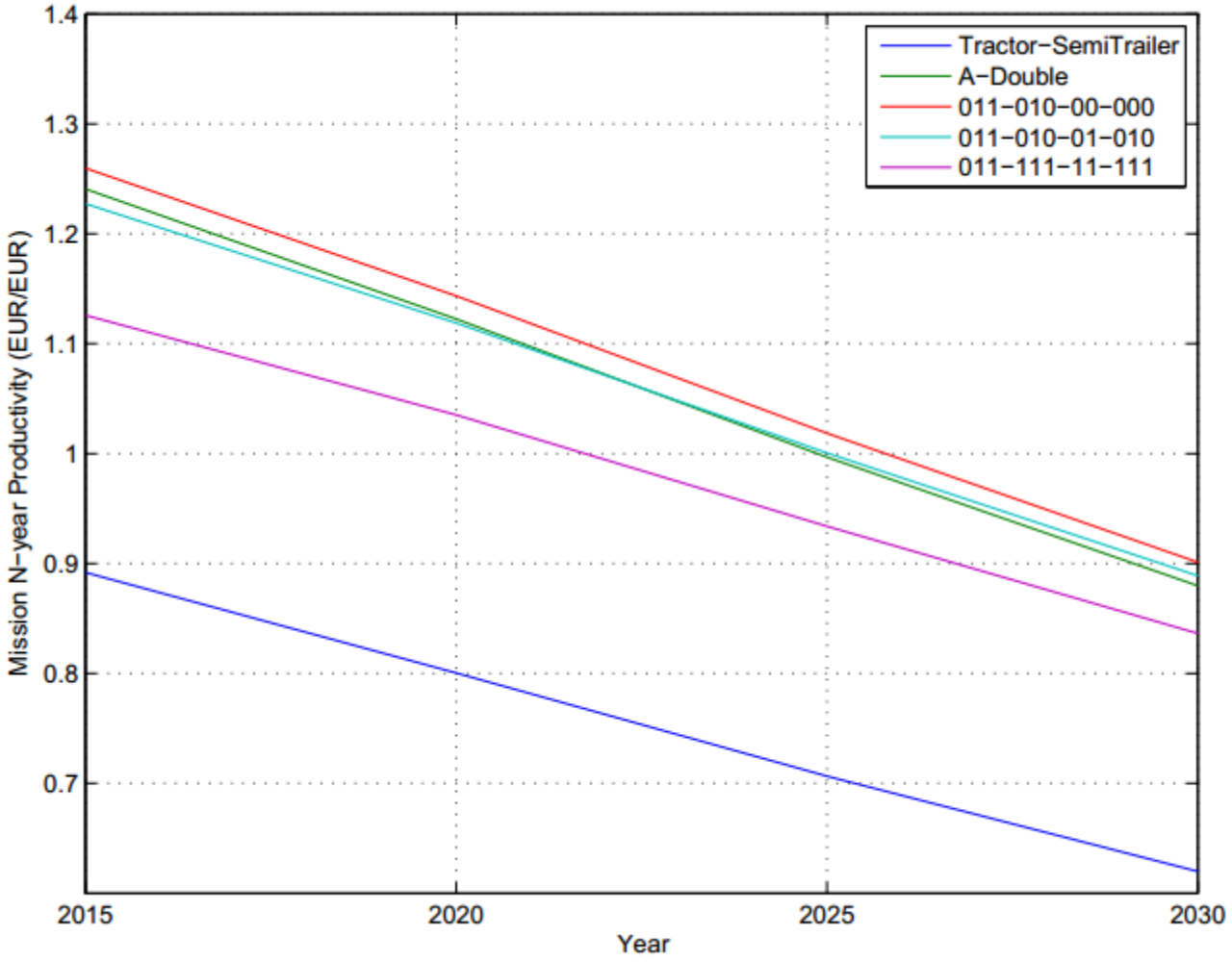
Sensitivity

	2015	2020	2025	2030
Fuel price per litre	1.468	1.702	1.973	2.287
Electricity price per kWh	0.21	0.24	0.282	0.327
Driver hourly wages	24	27.459	31.418	35.948

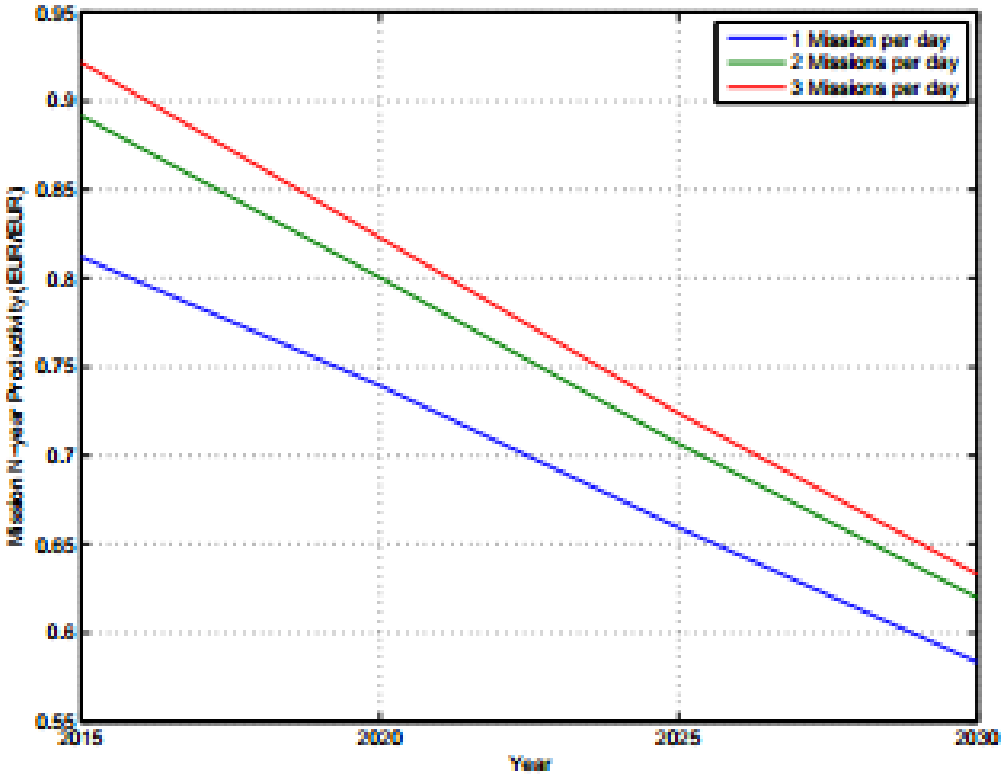
Battery Size (kWh)	2015	2020	2025	2030
5	1.657	1.045	0.927	0.874
50	16.57	10.45	9.27	8.74
90	29.82	18.81	16.69	15.73

Battery Size (kWh)	2015	2020	2025	2030
5	167	128.724	116.842	116.188
50	524	403.899	366.619	364.566
90	918	707.594	642.283	638.687

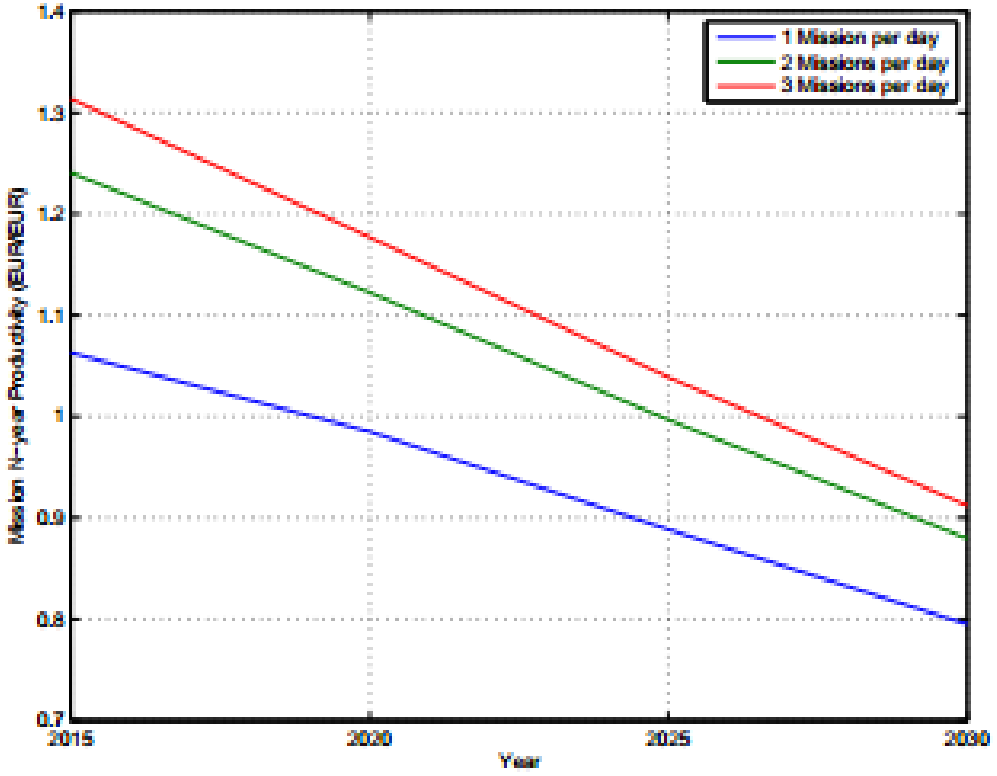
N-year productivity mapped over years



Daily mission effect

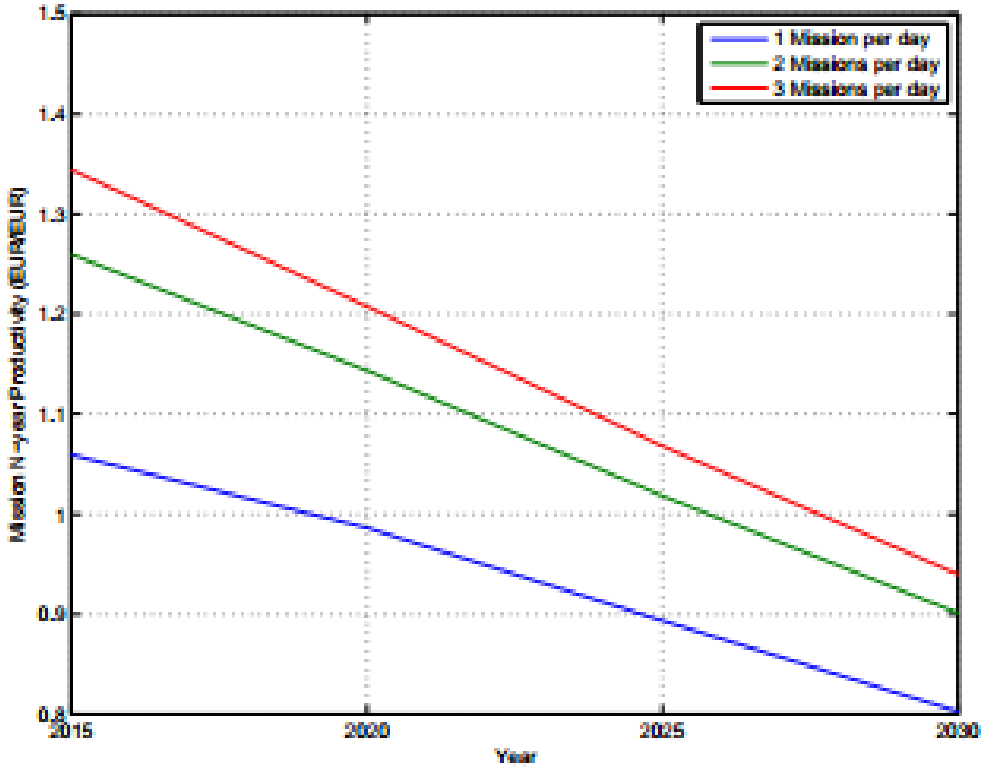


(a) *Tractor-Semitrailer*

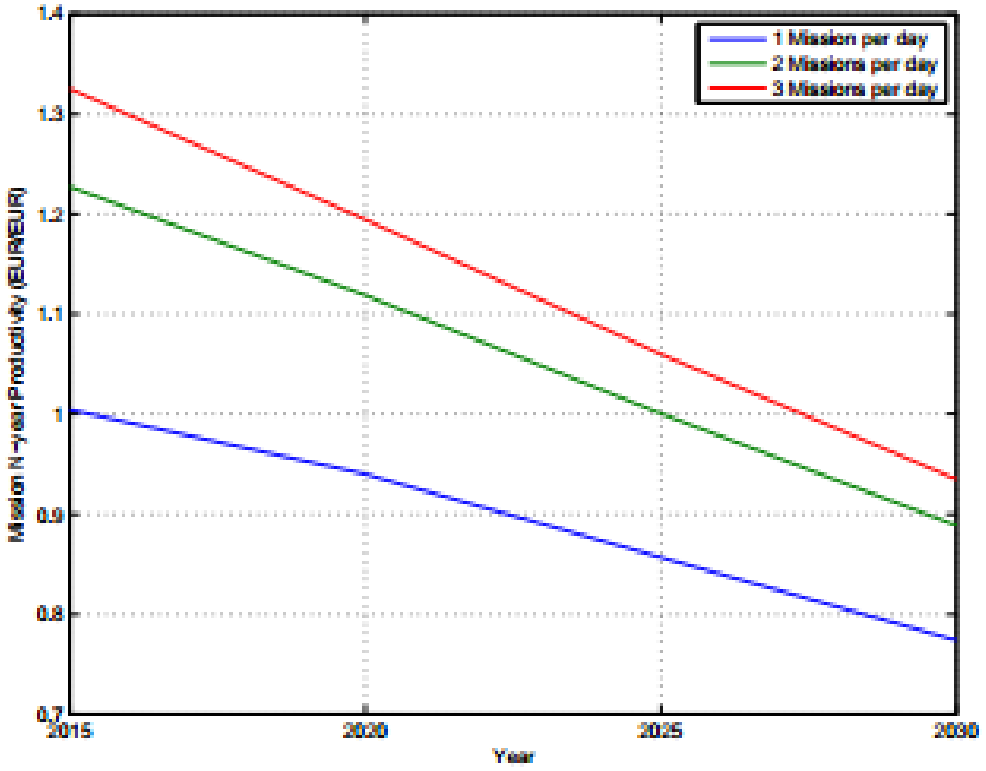


(b) *A-Double*

Daily mission effect - hybrids

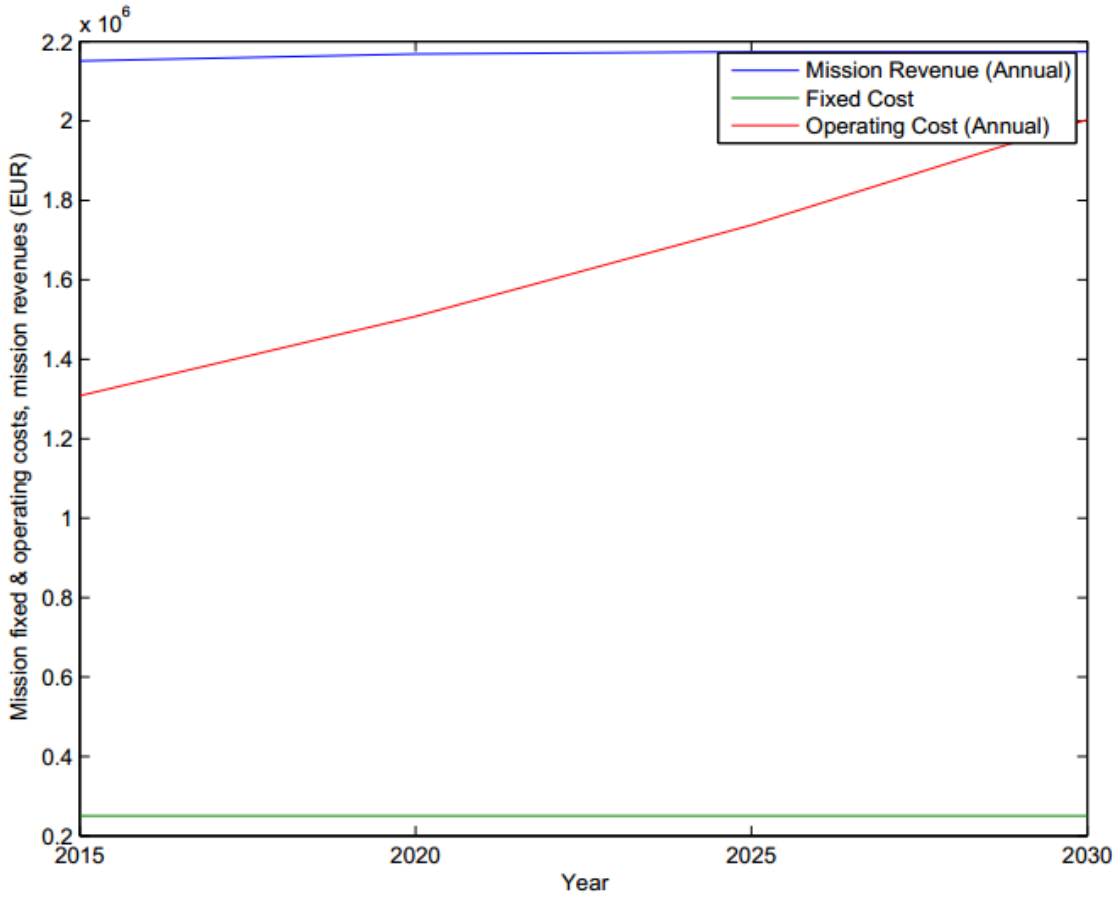


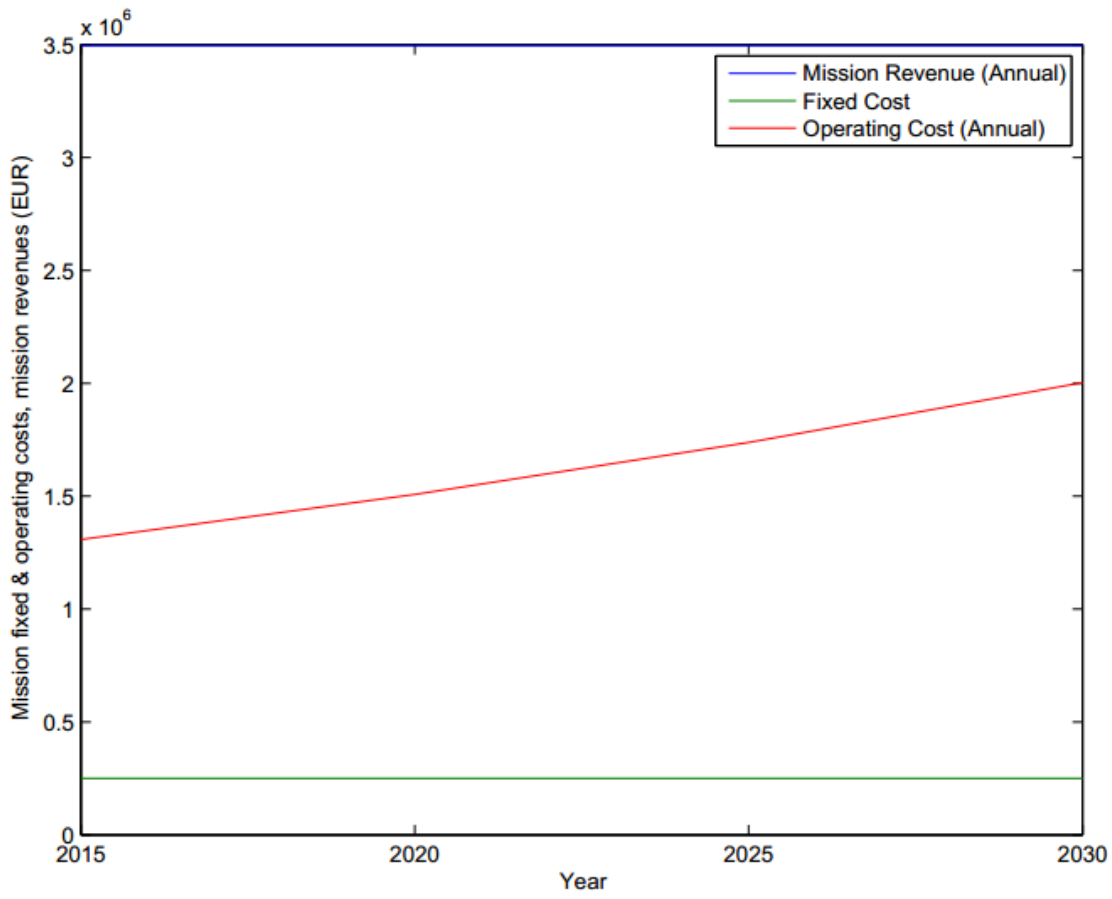
(c) *011-010-00-000*



(d) *011-010-01-010*

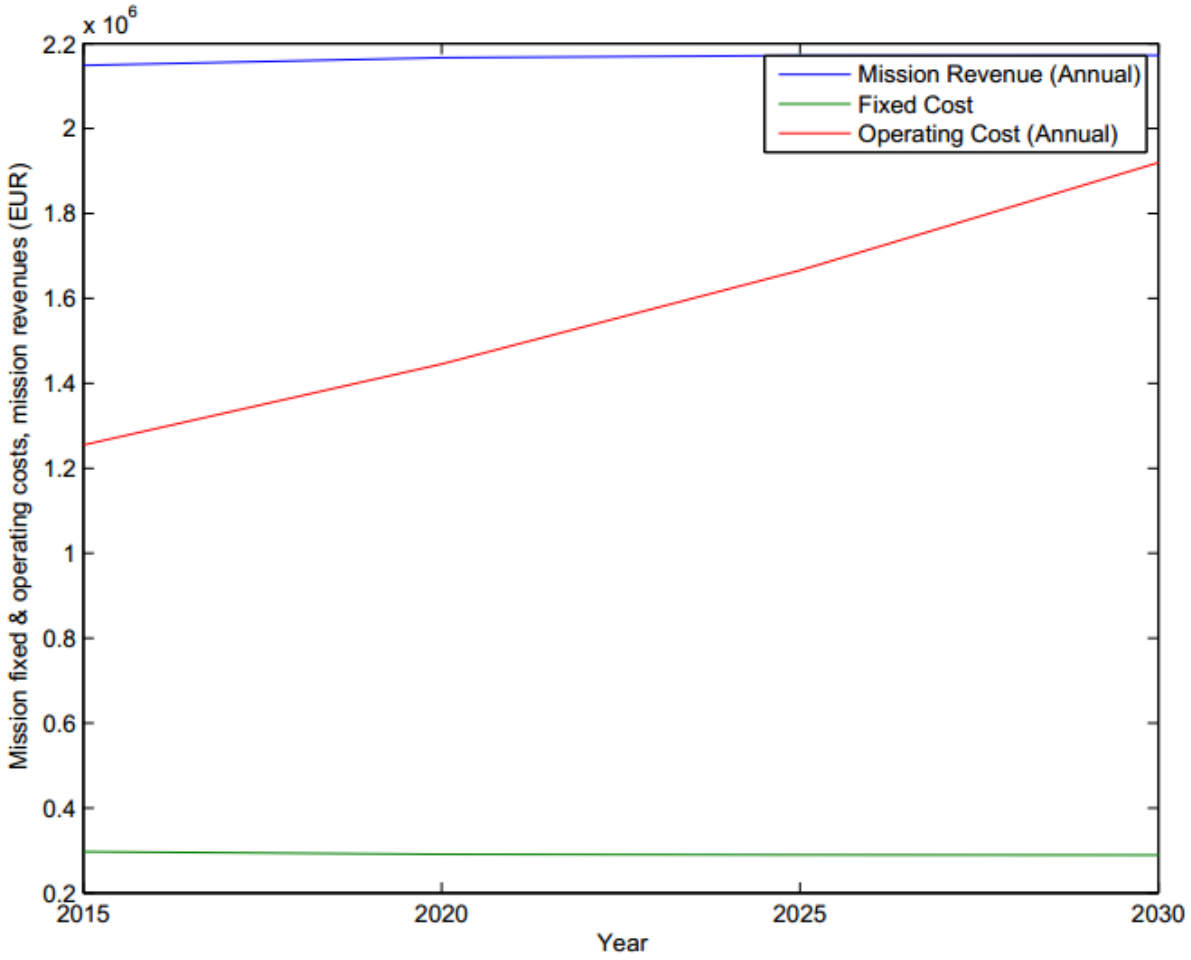
Effect of Freight-Based Revenue – A-Double

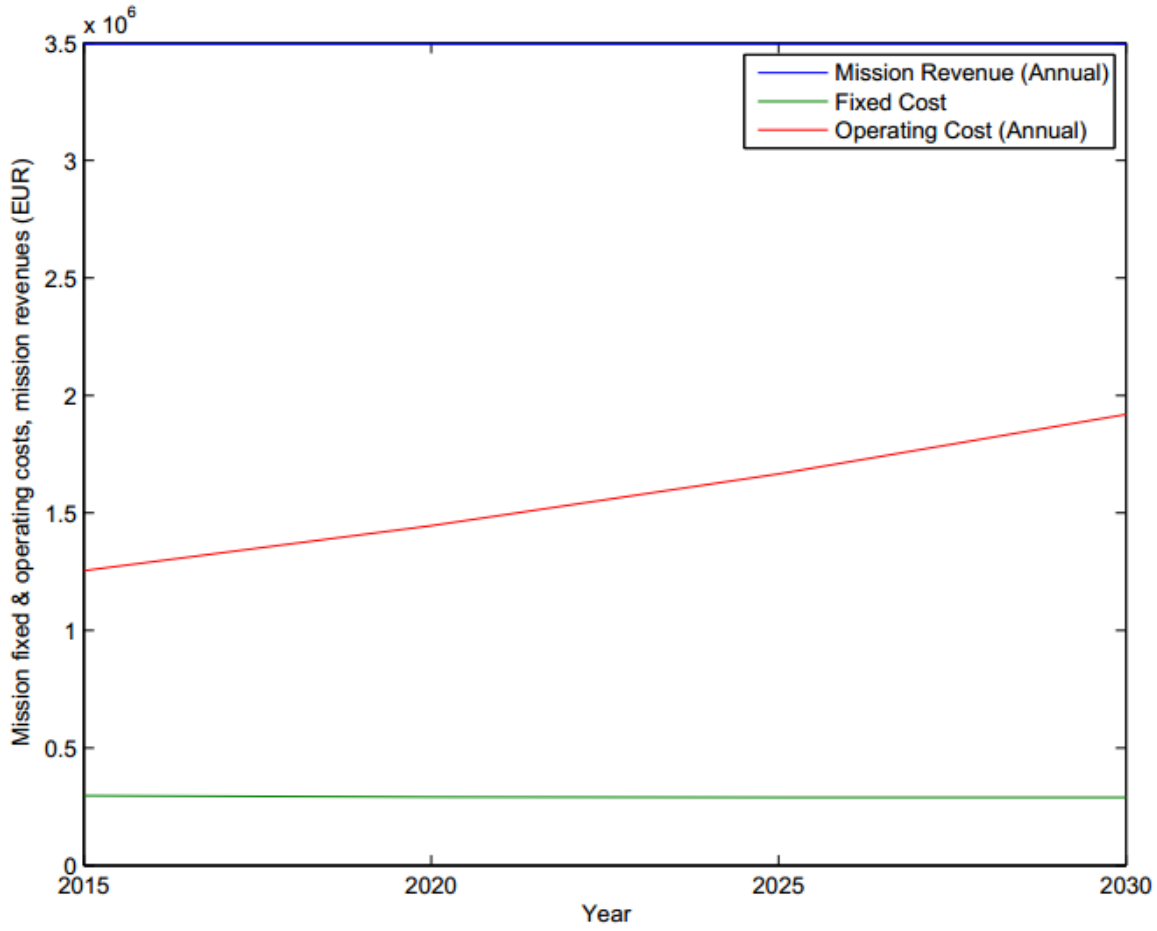




011-000-00-000, D16, 70t

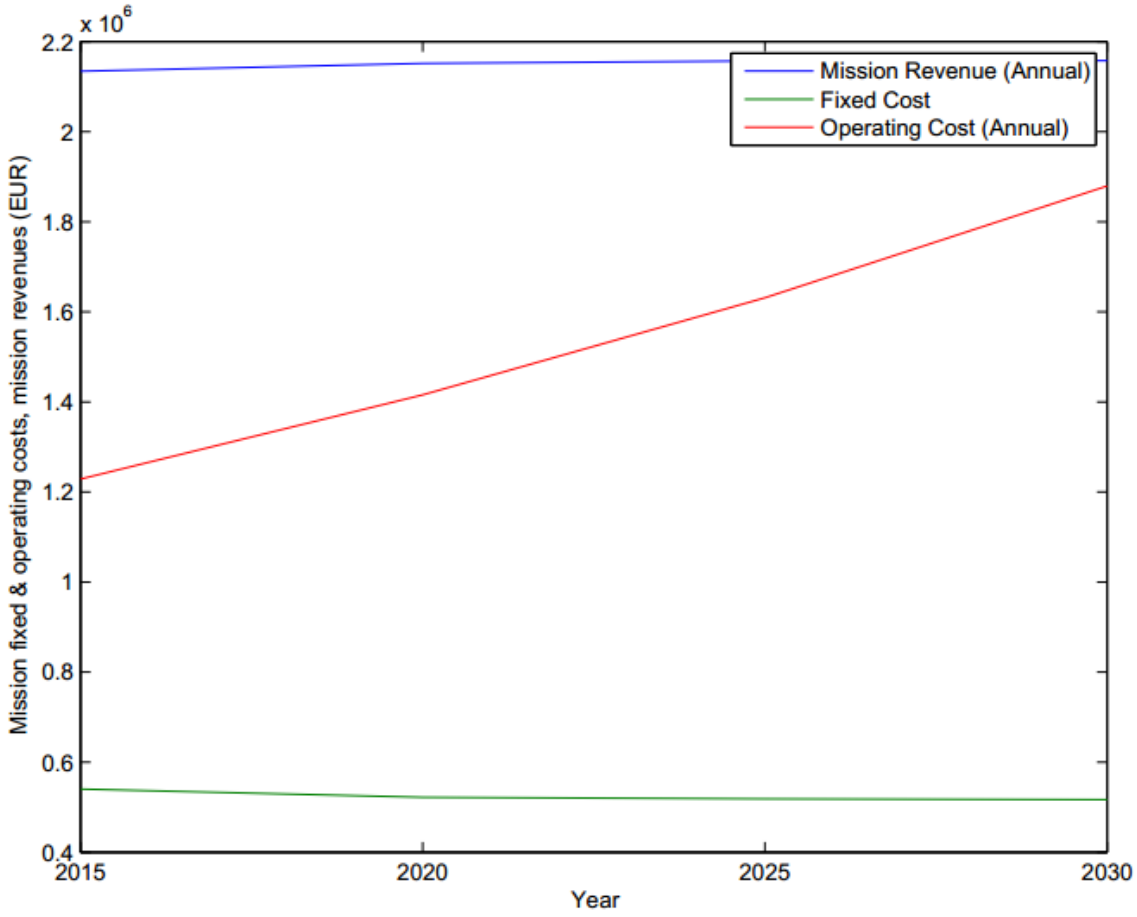
Effect of Freight-Based Revenue – Mild Hybrid

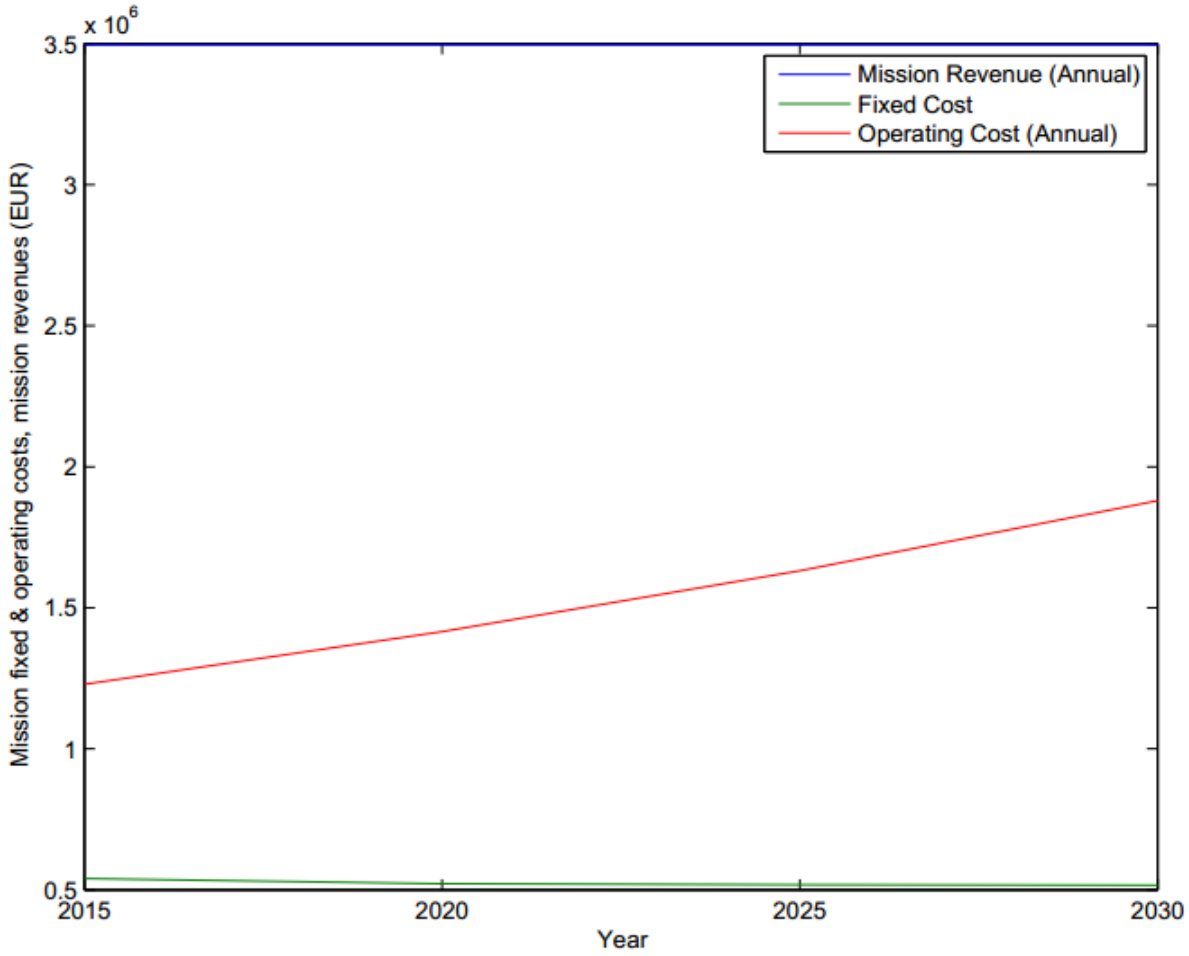




011-010-00-000, D16, 70t

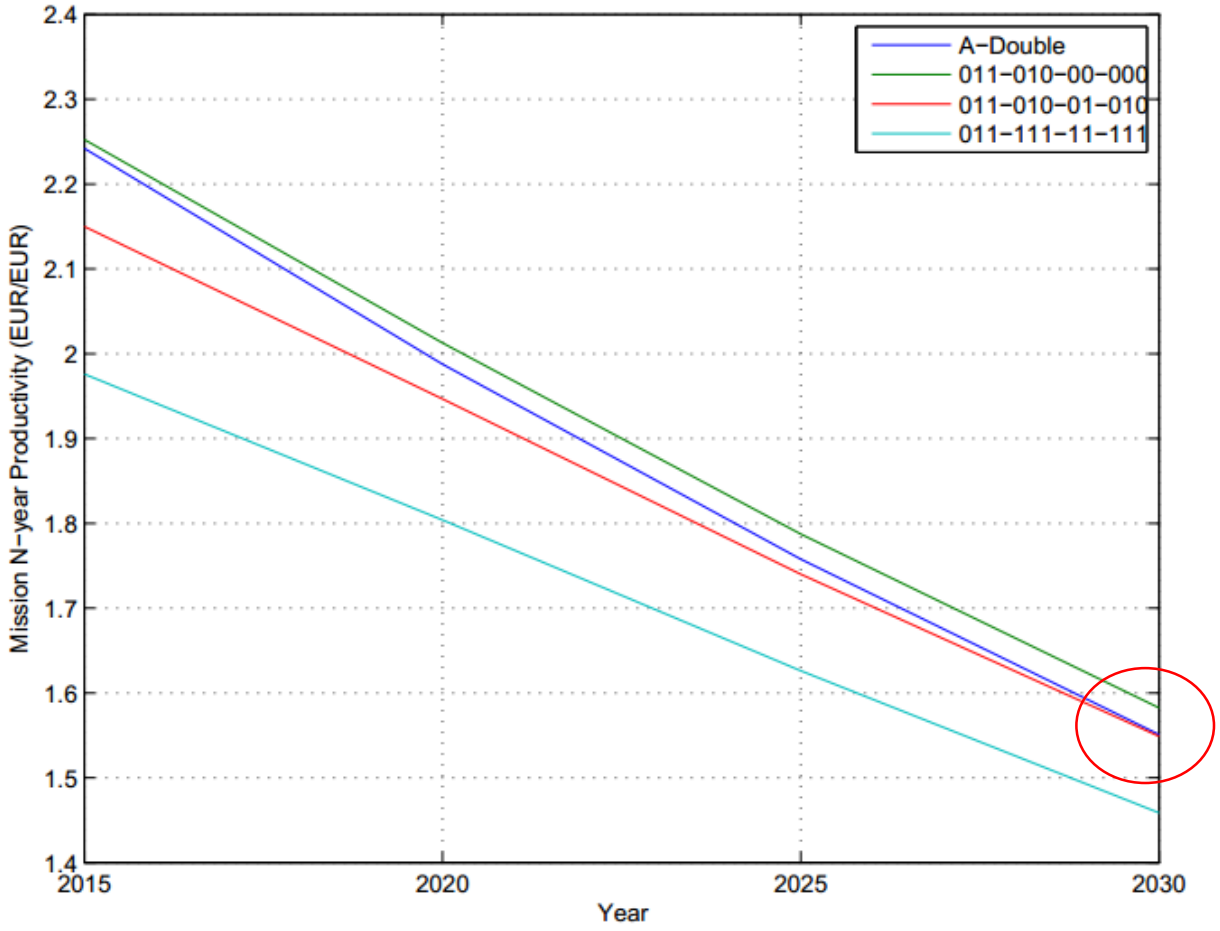
Effect of Freight-Based Revenue – ‘Mega’ Hybrid



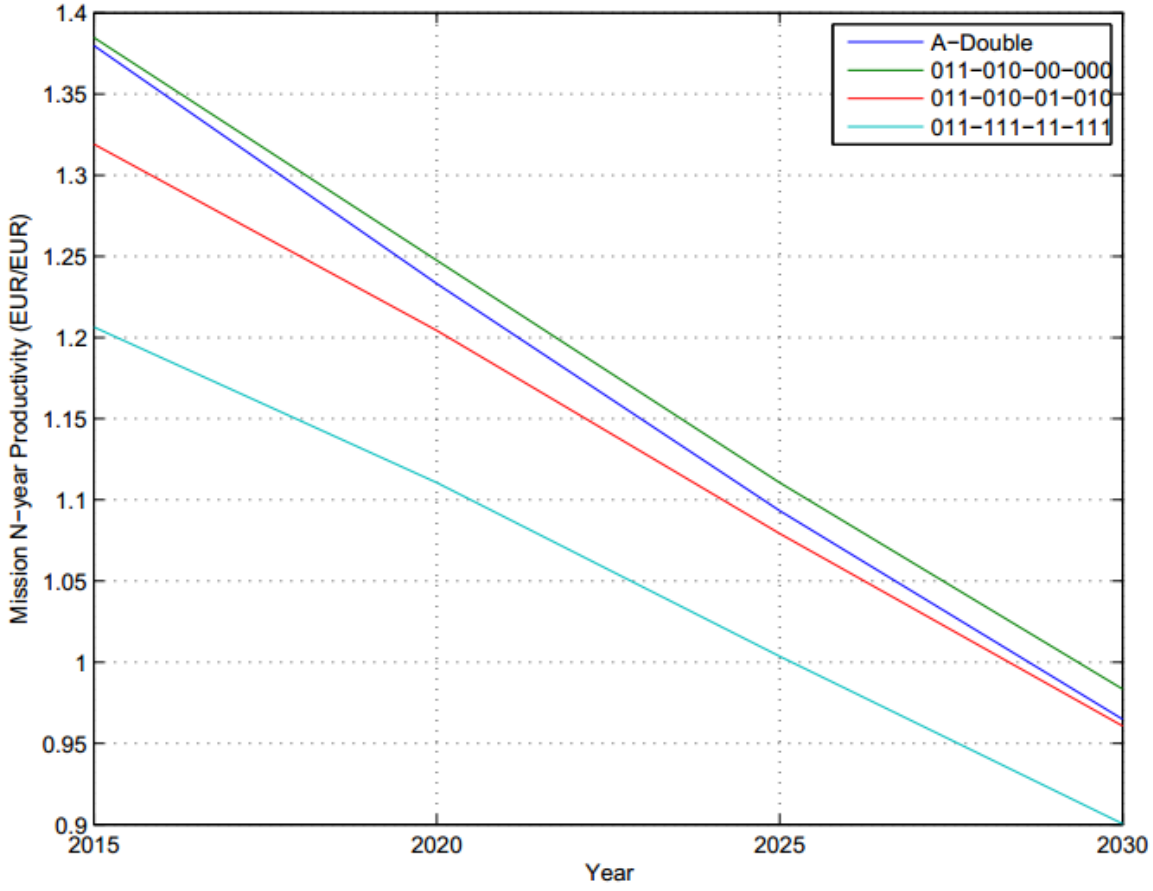


011-111-11-111, D16, 70t

Productivity trends – variable vs fixed revenue

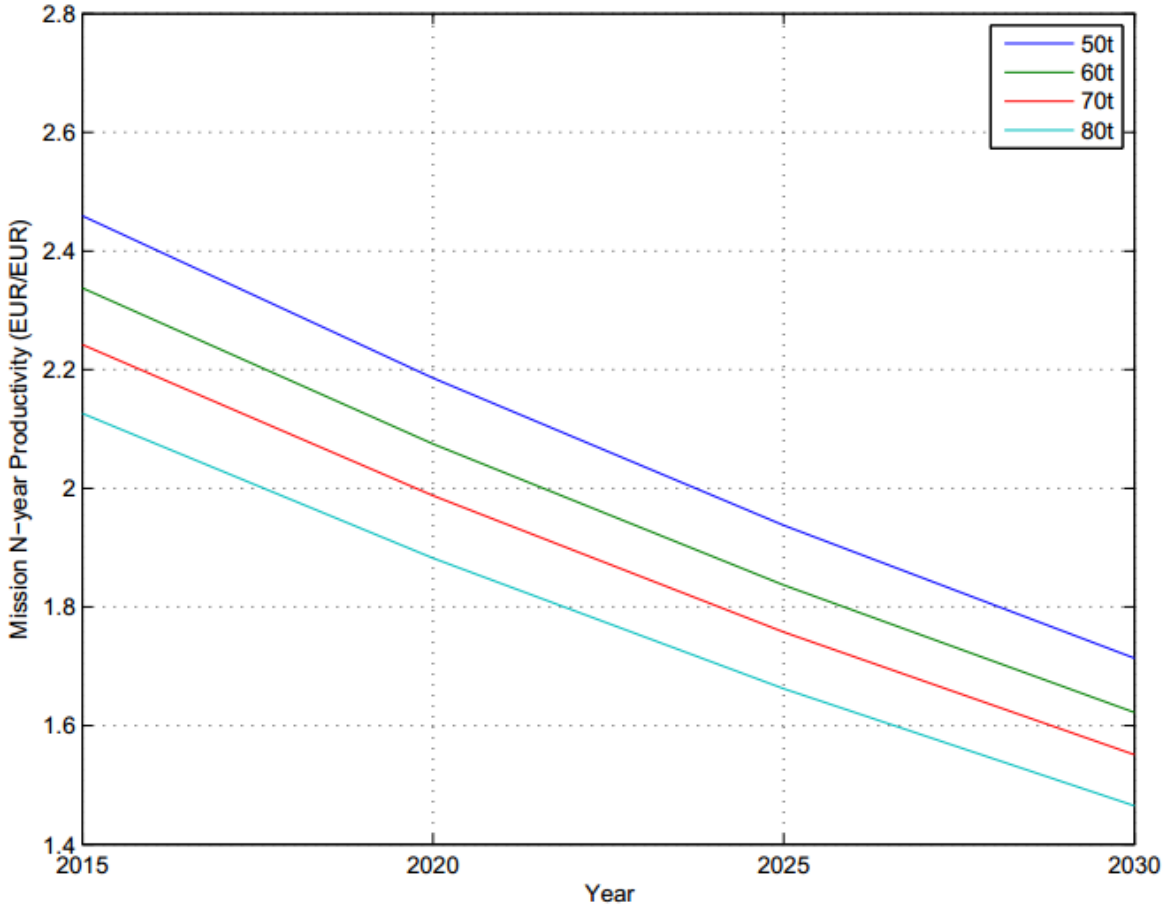


Fixed revenues – independent of freight

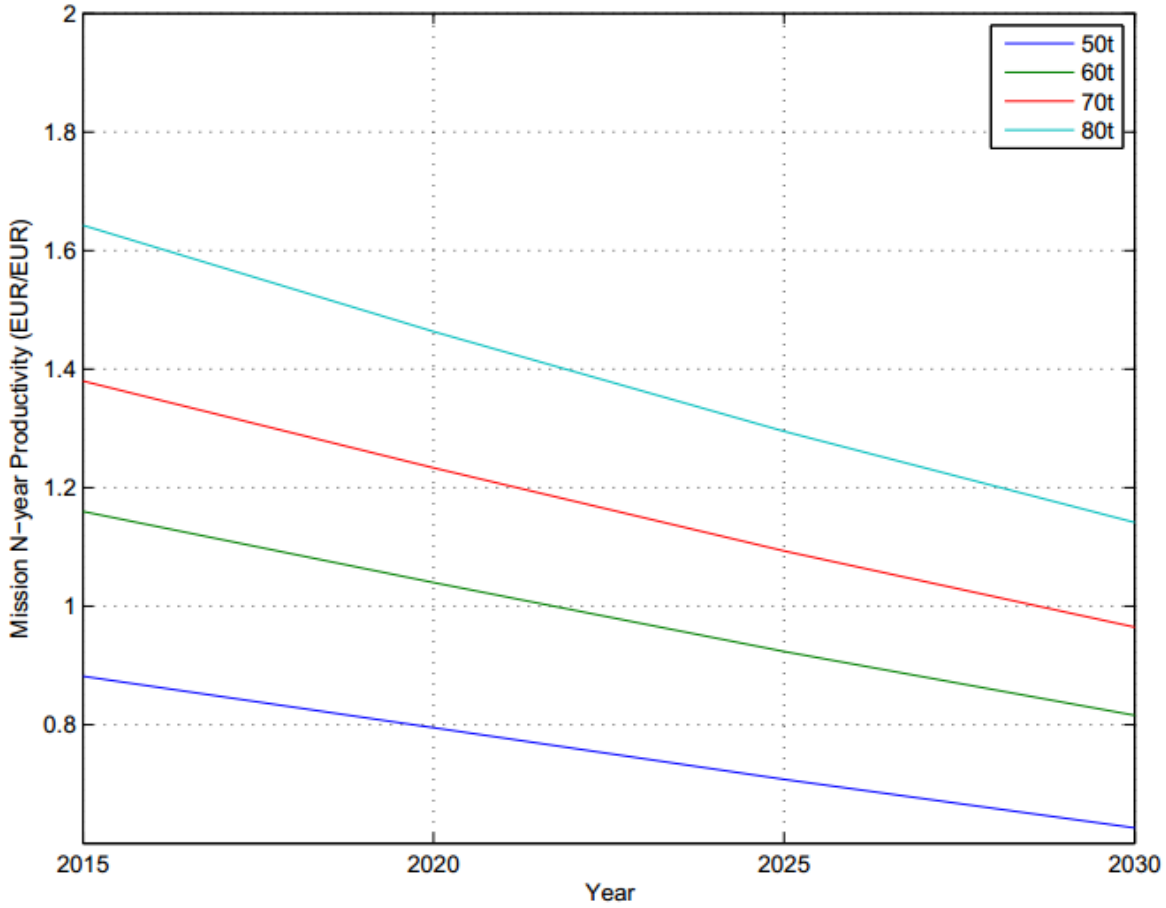


Freight-dependent variable revenues

A-Double productivity – variable / fixed - GCW

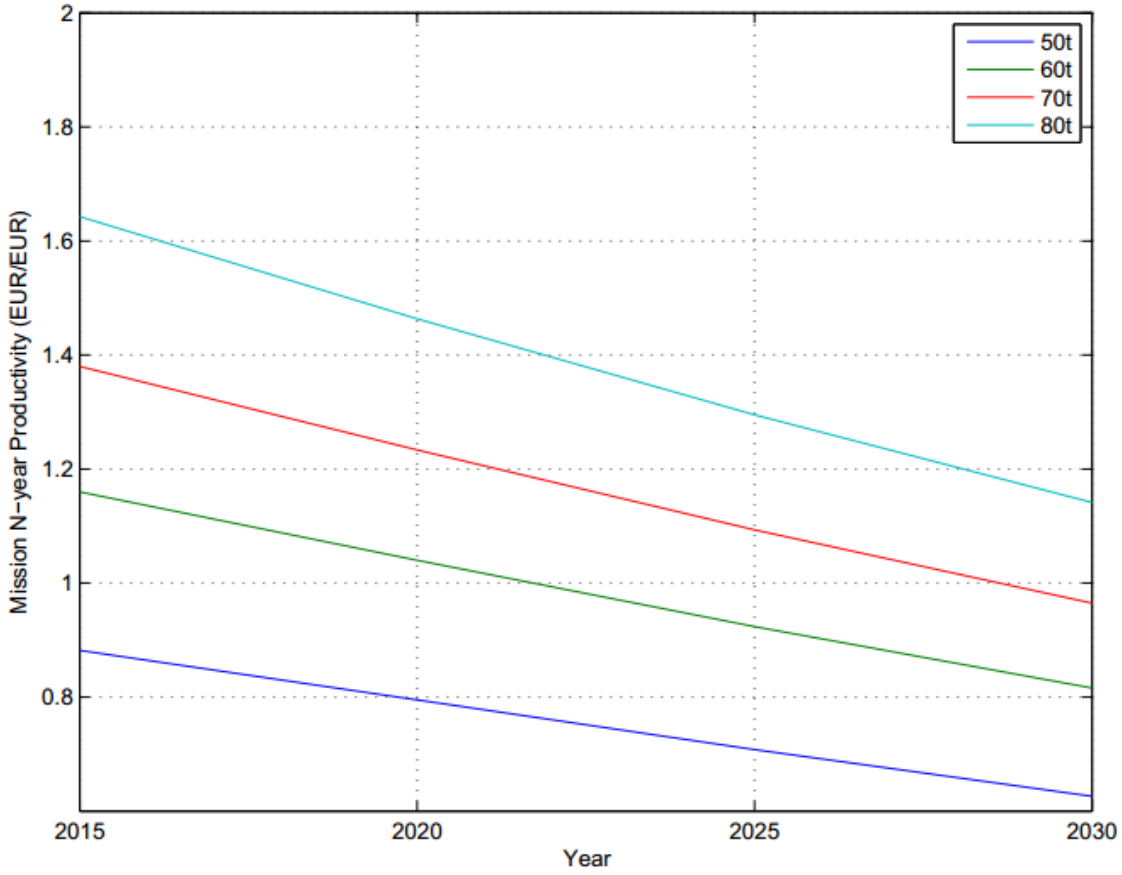


Fixed revenues – independent of freight

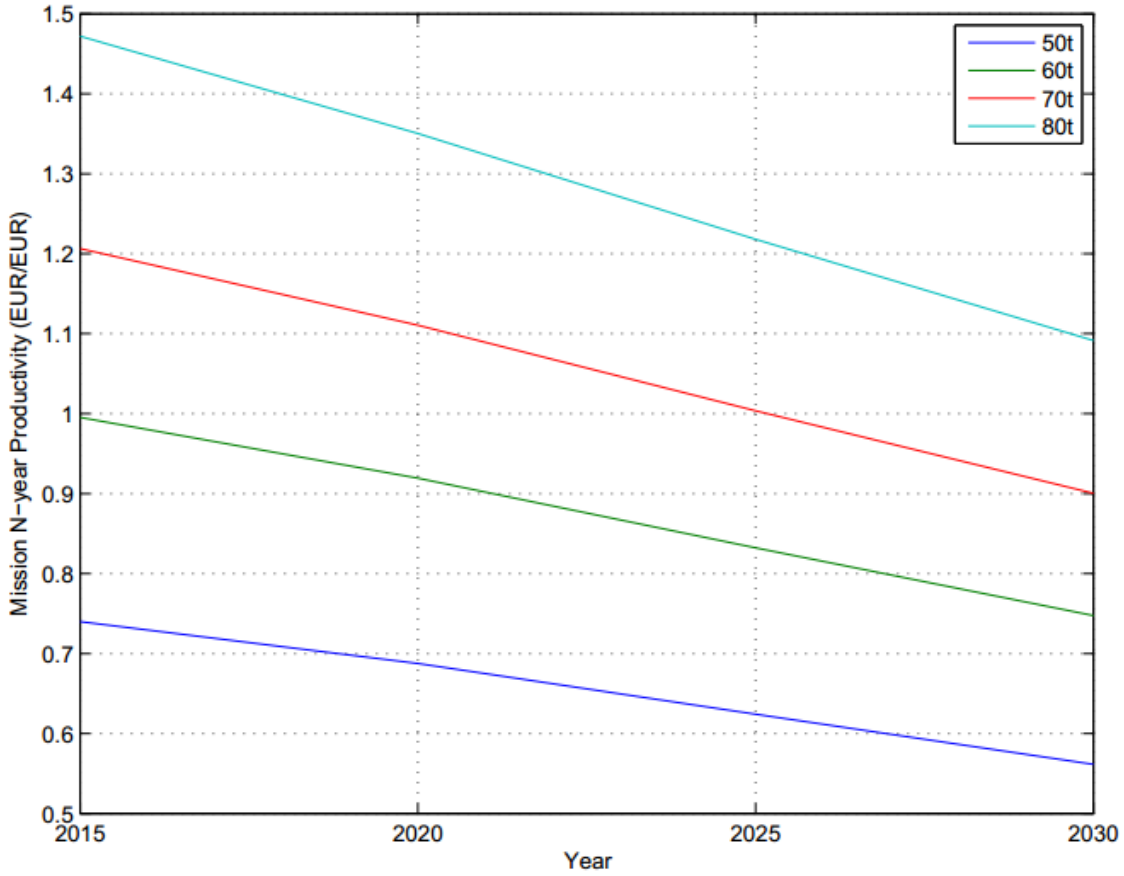


Freight-dependent variable revenues

Variable Revenues – Conventional vs Full Hyb.

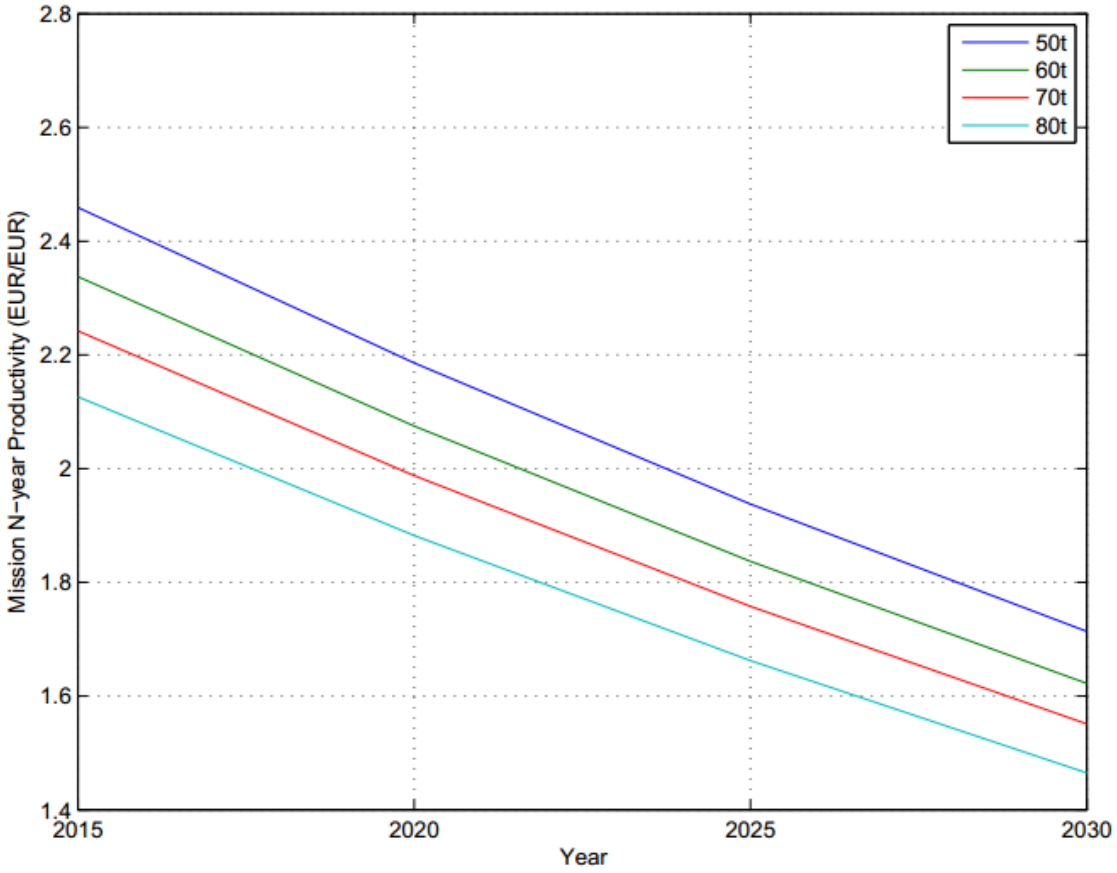


A-Double

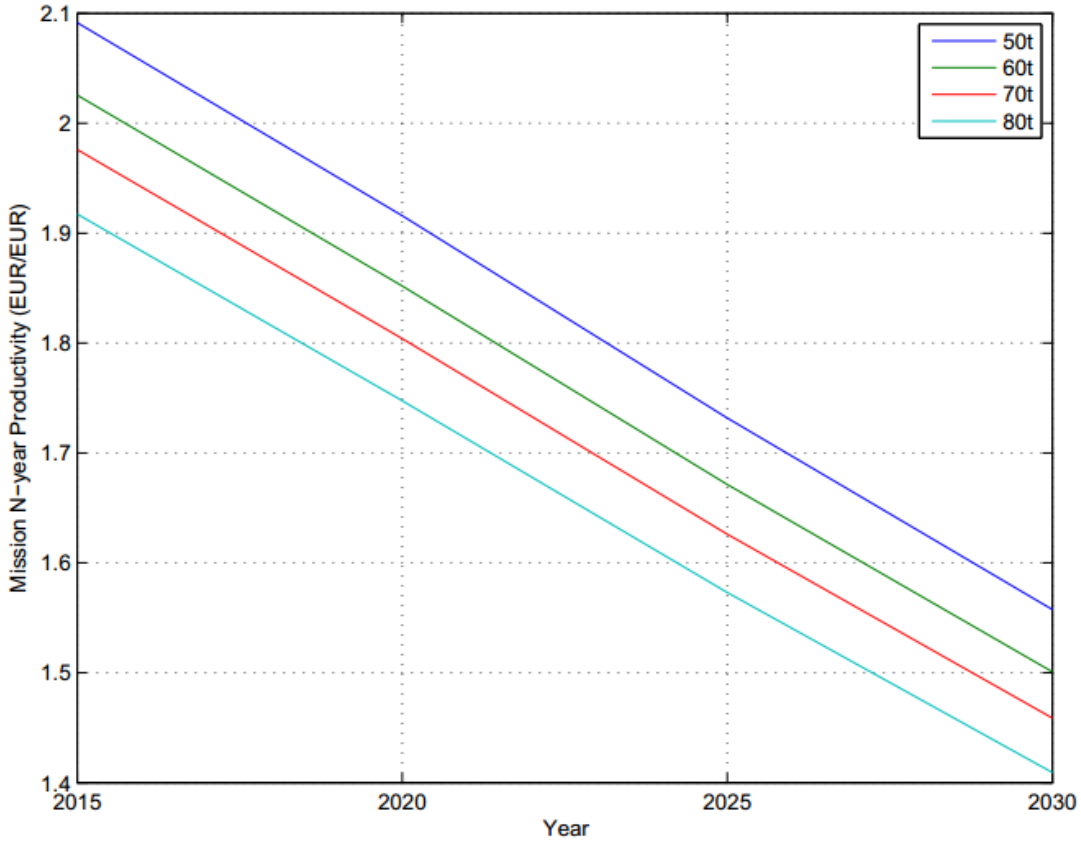


Full hybrid – 011-111-11-111

Fixed Revenues – Conventional vs Full Hyb.



A-Double



Full hybrid – 011-111-11-111

Other analysis

- Productivity as a measure of mission distance – optimal combinations for each mission distance identified
- Cheap / expensive fuel
- Cheap / expensive batteries

Thanks! Questions?