

Volumetric Method for Determining kg CO₂ eq. and Energy Requirements for the Production of Power Tools at an Early Stage of Product Design

Richard Sovják, Ing. et Ing.

Supervisor: doc. akad. soch. Ladislav Křenek, ArtD.

Co-supervisor: Ing. Marie Tichá (UJEP)

Institute of Machine and Industrial Design
Faculty of Mechanical Engineering
Brno University of Technology



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CONTENT

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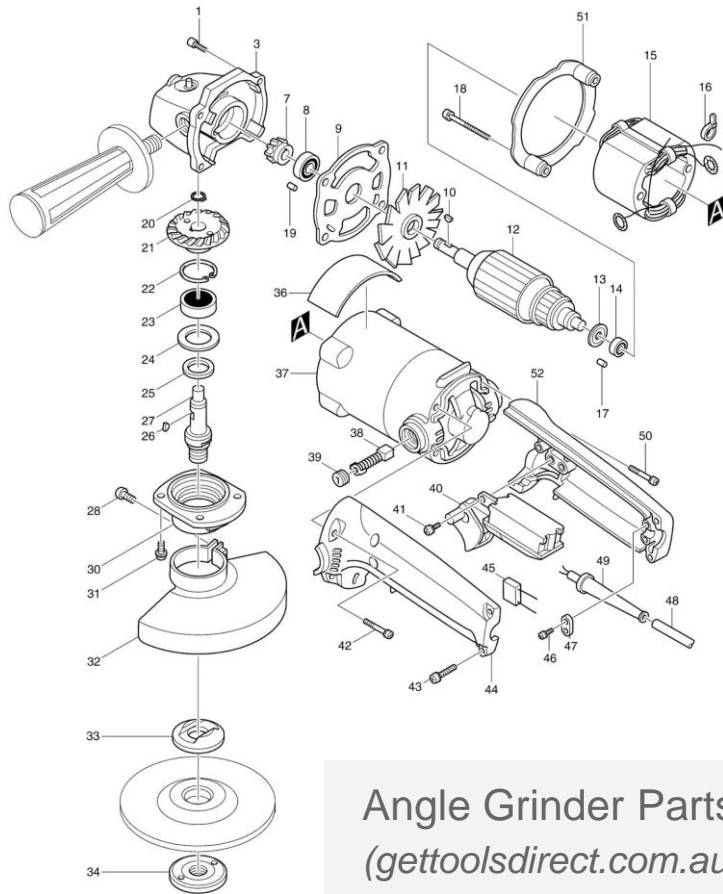
Conclusions



Diagram of LCA
(genitronsviluppo.com)

MOTIVATION AND INTRODUCTION

MOTIVATION



LCA

- Production
- Manufacturing
- Transport
- Use
- End of Life

Energy
Emission
Parts



Early Stage of Design

- Volume
- Type of power tools

Energy?
Emission?
Parts?

STATE OF THE ART

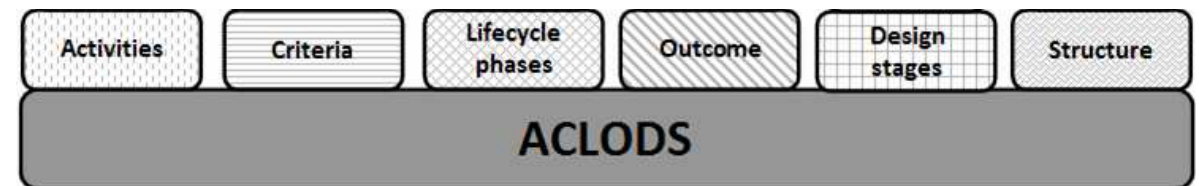
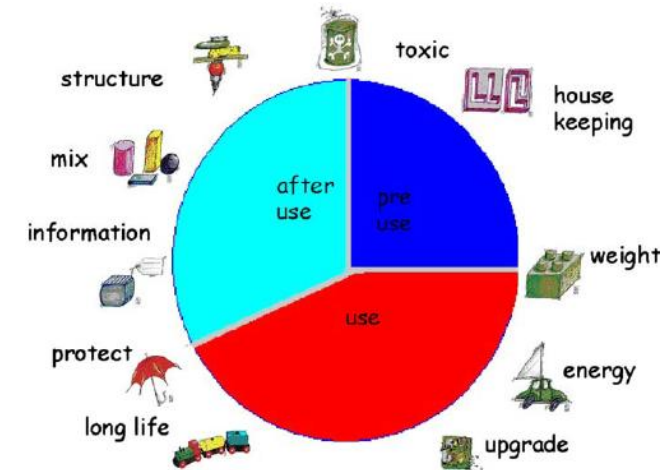
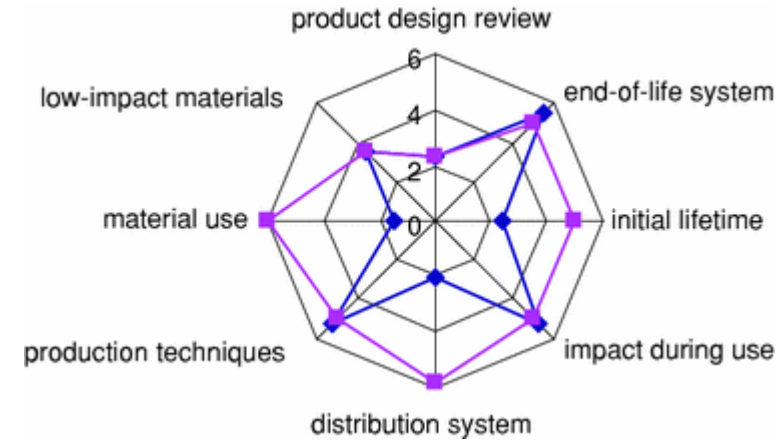
QUALITATIVE APPROACH

IAN, Thomas, Focus 3: EMS and EIA: Topic 7: Life Cycle Analysis: Introduction and Background, 2016

LUTTROP, Conrad and Jessica LAGERSTEDT. EcoDesign and The Ten Golden Rules: generic advice for merging environmental aspects into product development, 2006

KOTA, Srinivas and Amaresh CHAKRABARTI, ACLODS – A holistic framework for environmentally friendly product lifecycle design, 2011

- Checklists, Volvo Lists, etc.



STATE OF THE ART

QUANTITATIVE APPROACH

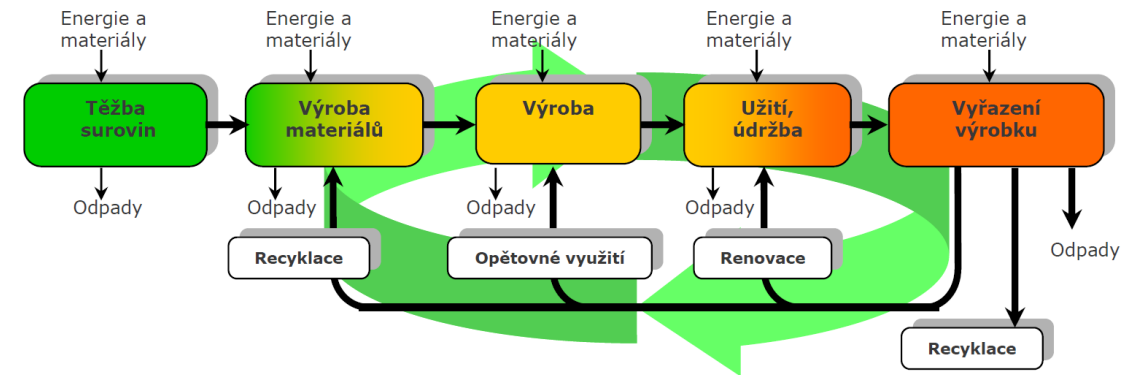
ISO 14044:2006: Environmental management -- Life cycle assessment -- Requirements and guidelines, 2006

WEINZETTEL, Jan, Input output analýza. Úvod | Databáze vysokoškolských kvalifikačních prací zaměřených na LCA, 2008

BEY, Nicki, The Oil Point Method: A tool for indicative environmental evaluation in material and process selection, 2000

1 Oil Point (OP) = Energy of 1 kg crude oil = 45 MJ

- MECO matrix, MET matrix, METto matrix, KEPI, TPI
- Software GaBi, openLCA, SimaPro



Ekonický sektor / Produkt	Ekonický sektor 1	Ekonický sektor 2	...	Ekonický sektor n	Konečná spotřeba	Celková spotřeba
Produkt 1	U matice				y ₁	t ₁
Produkt 2					y ₂	t ₂
...					y _{...}	t _{...}
Produkt n					y _n	t _n

Ekonický sektor / Produkt	Ekonický sektor 1	Ekonický sektor 2	...	Ekonický sektor n	Celková domácí výroba
Produkt 1	M matice				Σ řádku = q ₁
Produkt 2					Σ řádku = q ₂
...					Σ řádku = q _{...}
Produkt n					Σ řádku = q _n
Celkové produkce ES	Σ sloupce = g ₁	Σ sloupce = g ₂	Σ sloupce = g	Σ sloupce = g _n	

ANALYSIS OF LITERATURE REVIEW

RESULTS

- Industrial designers do not use quantitative LCA tools
- Industrial designers and students want to know environmental impacts
- Eco-design tools must be visualised
- Pollution is closely linked to the production site

QUALITATIVE APPROACH

- Quick results (VOLVO lists, LiDS Wheel, Checklists, ...)
- Only for quick assessment
- Early stage of design



QUANTITATIVE APPROACH

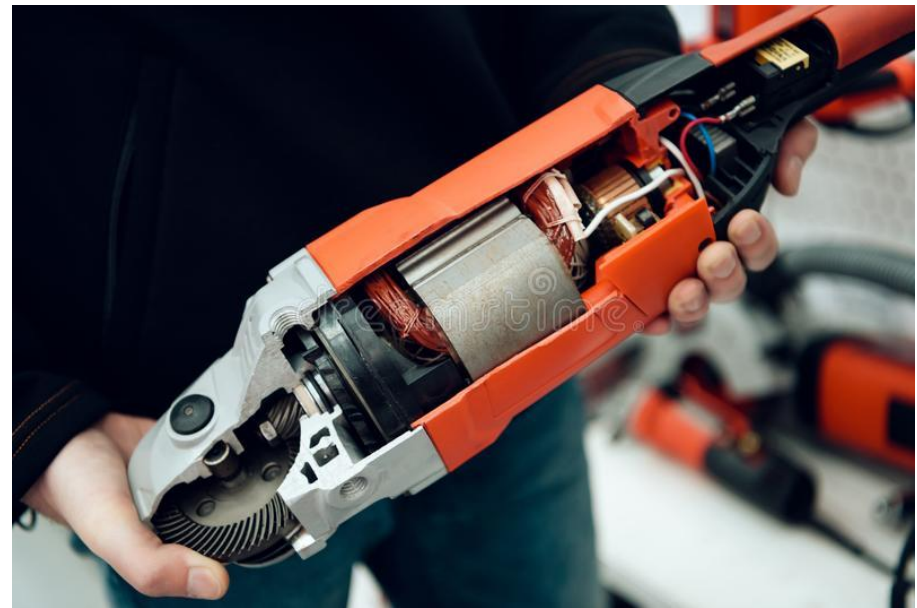
- Best results for full LCA
- Expensive software (SimaPro, Gabi, openLCA, ...)
- Time-consuming
- Best methods are OPM or IO

AIM OF THE THESIS

Develop a method for quantifying the emission of kg CO₂ eq. and energy inputs at a very early design stage using statistical processing of data from an LCA-based tool from defined product categories using their volume and material composition.

Partial Aims

- Classifying power tools
- Inventory analysis
- End of Life (3 phases)
- Simulation of LCA by different EoL
- Emissions CO₂ per selected country
- Web interface (energy, emissions and benefits)



Angle Grinder
([dreamstime.com](https://www.dreamstime.com))

AIM OF THE THESIS

SCIENTIFIC QUESTIONS

- How does the size and type of product affect environmental pollution?
- Can the amount of emissions kg CO₂ eq. and energy consumption for production be based only on the volume and nature of the product?

RESEARCH HYPOTHESES

- Environmental pollution depends on the volume and characteristics of the power tools
- Emissions kg CO₂ eq. can be specified according to the location of production
- Determined emission of the energy mixes of each country or economy

MATERIALS AND METHODS

RANGE OF SAMPLES

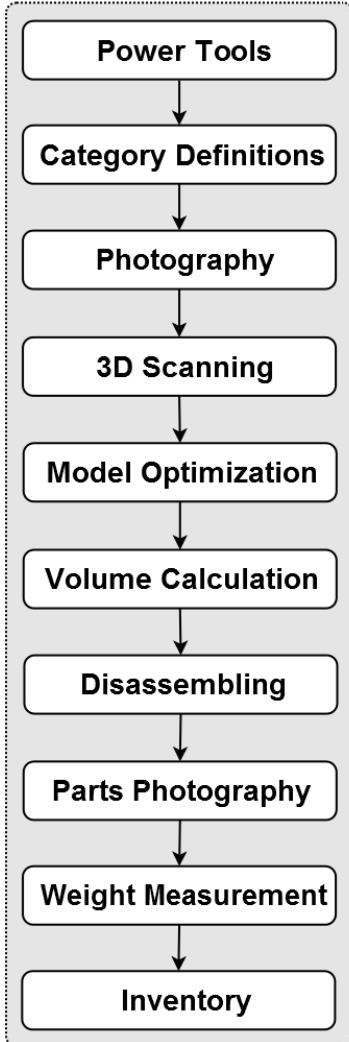
- Random Orbital Sanders (6 pcs.)
- Sheet Sanders (16 pcs.)
- Electric Planers (9 pcs.)
- Handle Jigsaws (24 pcs.)
- Belt Sanders (7 pcs.)
- Percussion Drills (17 pcs.)
- Circular Saws (7 pcs.)
- Angle Grinders (26 pcs.)
- Electric Chainsaws (16 pcs.)
- Reciprocating Saws (6 pcs.)

134 pcs. power tools, 310 kg of samples

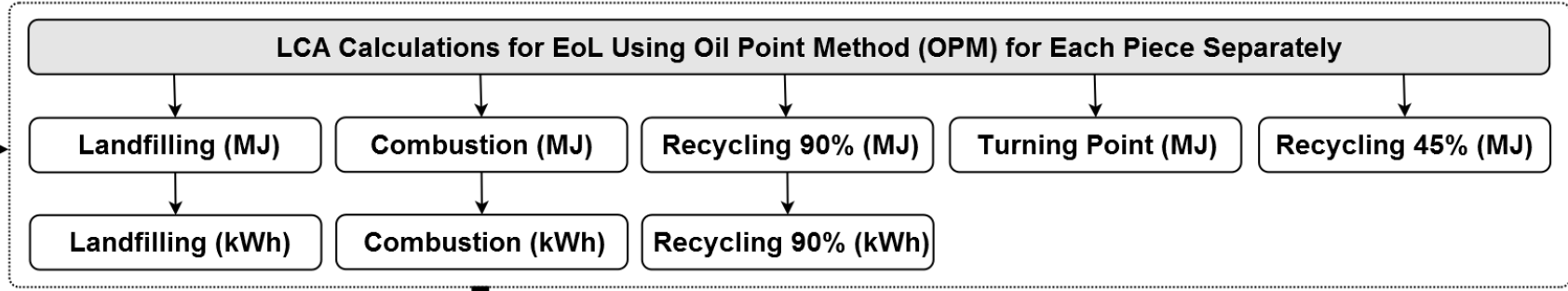


MATERIALS AND METHODS

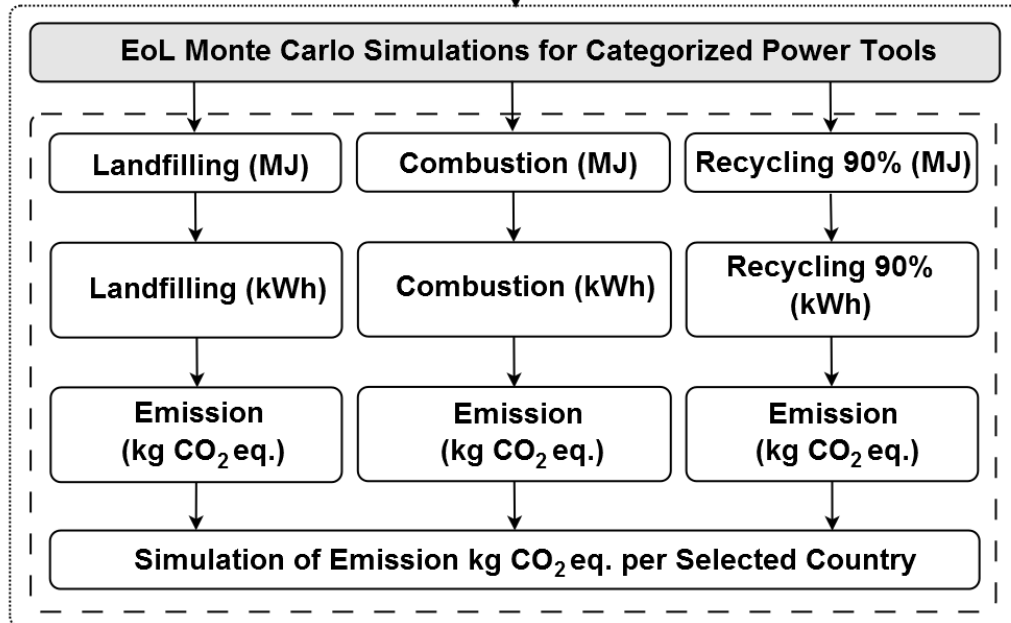
Data Preparation



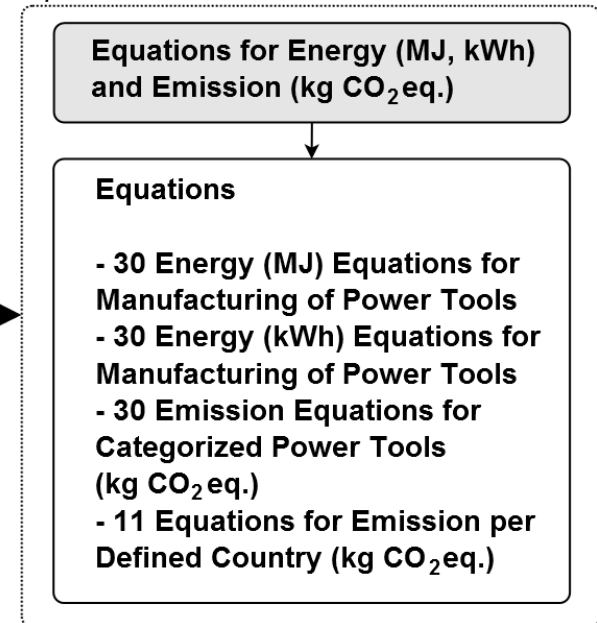
LCA Analysis



LCA Simulations



Equations from Simulations



MATERIALS AND METHODS

METHODOLOGICAL GUIDELINES

- Cable and plug free
- Without tools, bars, chains, etc.
- No refills that are consumed during the use of the tools (lubricants)
- Possible missing parts, but always as little damage to the housing as possible
- Ignoring wear and tear on internal components
- Disassembly into the smallest possible parts and components
- Always get half the windings from the stators
- Calculating **welds** and **including surface finishes** on parts
- Assembling the products (0.007 kWh/min) was not calculated
- **Recycling percentage linear on all parts**
- **No service interventions or repairs to the products during the use phase**
- **Only a complete 360° 3D scan of the tools**

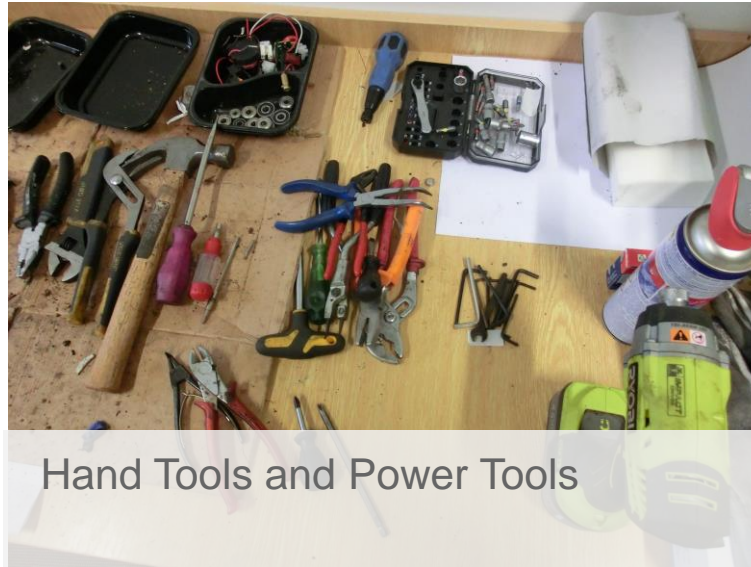
MATERIALS AND METHODS

USED TOOLS AND SOFTWARE

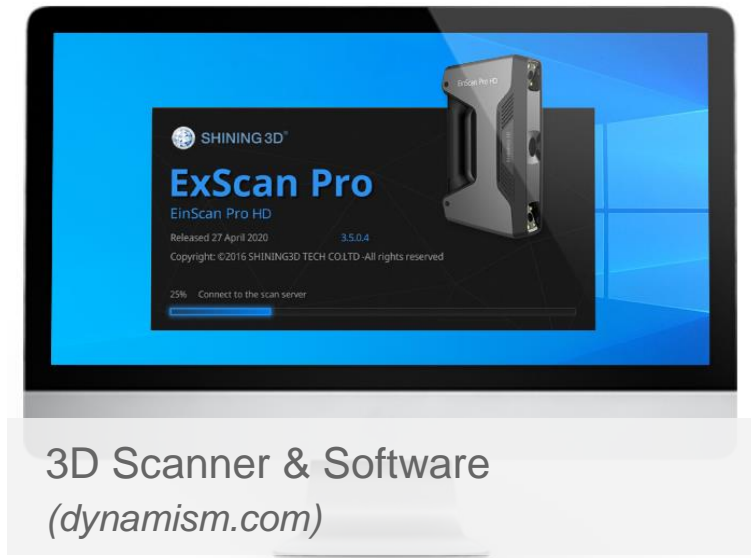
- Scale Device and Measuring Instruments
- 3D Scanner and Camera
- Hand Tools and Power Tools
- Software (Rhinoceros 7, ExScan and MS Excel)



Scale Device



Hand Tools and Power Tools



3D Scanner & Software
(dynamism.com)

MATERIALS AND METHODS

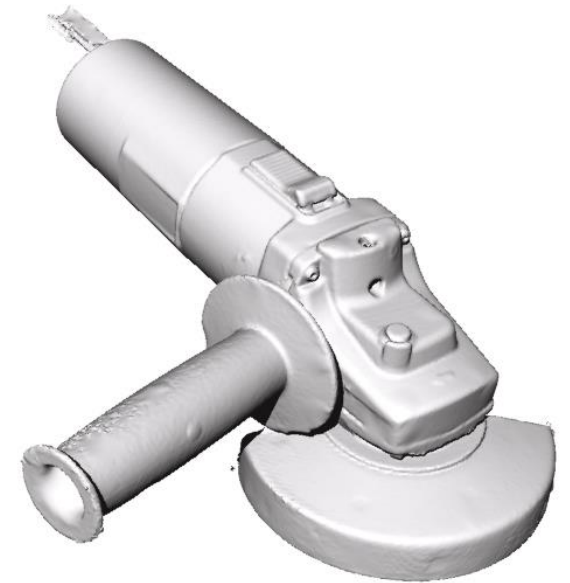
DATA PREPARATION (SURFACE)



Marking Points



Model from 3D Scanner



Cleared 3D Model

MATERIALS AND METHODS

DATA PREPARATION (STATOR & ROTOR)



Stator (Separated Winding)



Cut of Rotor Armature



Cut of Rotor Commutator

MATERIALS AND METHODS

LCA ANALYSIS - OIL POINT METHOD (OPM)

- Materials Production
- Manufacturing Processes
- Transport
- Use
- End of Life

Including New Tasks

- Packaging analysis
- Finding Turning Point
- Recycling 0% - 100%
- Recycling 45% (EU demand WEEE)



Crude Oil = 1 OP = 45 MJ Energy
(bloombergquint.com)

MATERIALS AND METHODS

LCA ANALYSIS – CALCULATION AND INPUTS

Materials and Processes

- Calculated Materials (+GF, TPE, Dural, Paints, POM, EPDM)
- Calculated Processes (Compressed Air, Hot Rolling, Low Pressure Die Casting)
- Calculated Products (Capacitors, PCB Composite, PCB Ceramic, V-Belts)

Input Data

- Transport calculation: from 2,500 km to 17,000 km transport (truck/van/ship)
- Use Phase (intensive 1,000 h)

MATERIALS AND METHODS

LCA ANALYSIS – END OF LIFE

- Landfilling = Recycling 0%
- Combustion (materials with Feedstock share)
- Recycling 90% and calculated from 0% to 100% (Fuelshare)



MATERIALS AND METHODS

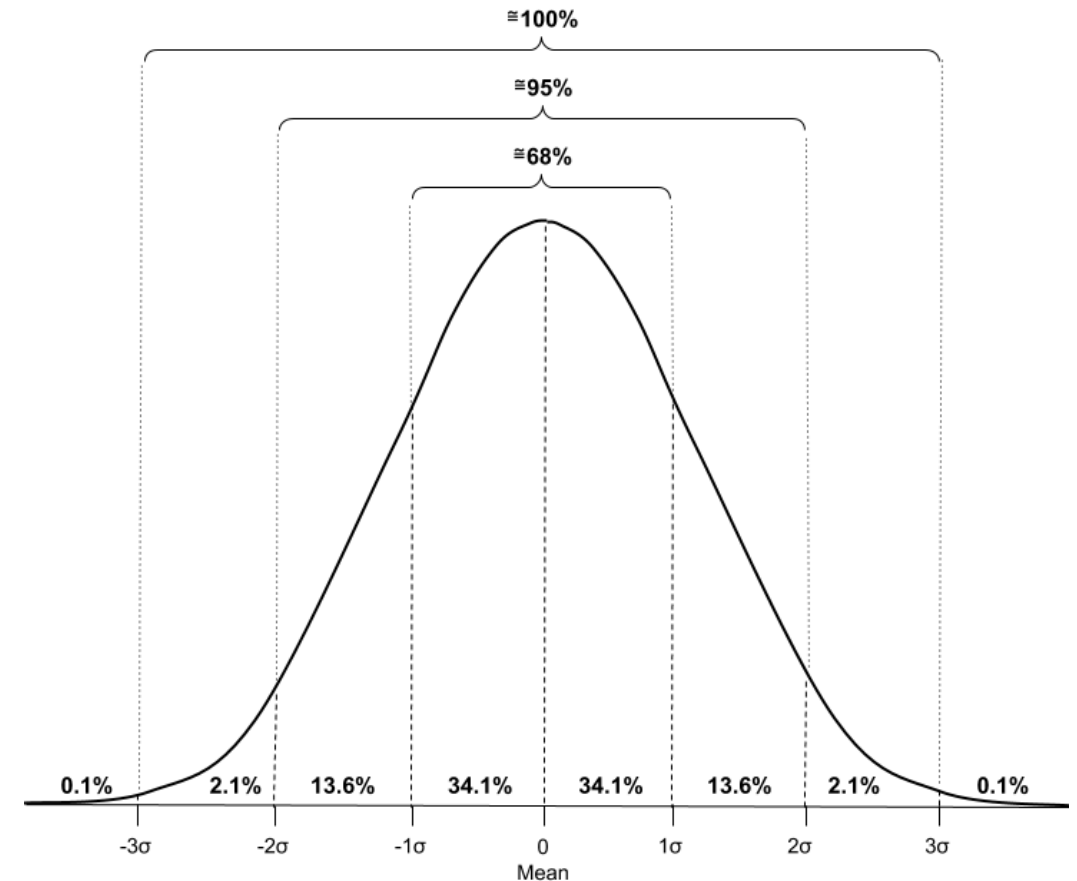
LCA SIMULATION

Monte Carlo

- Energy requirements MJ and kWh Units
- Emission kg CO₂ eq.
- Normal distribution
- 95% confidence, alpha = 0.05
- $n = 1,000$ steps power tools
- Calculation cor. coefficient ($n = 1,000$ iteration)

Equations from Simulations

- Energy requirements MJ (30), kWh (30)
- Emissions kg CO₂ eq. (30)
- Emissions kg CO₂ eq. by production location (11)



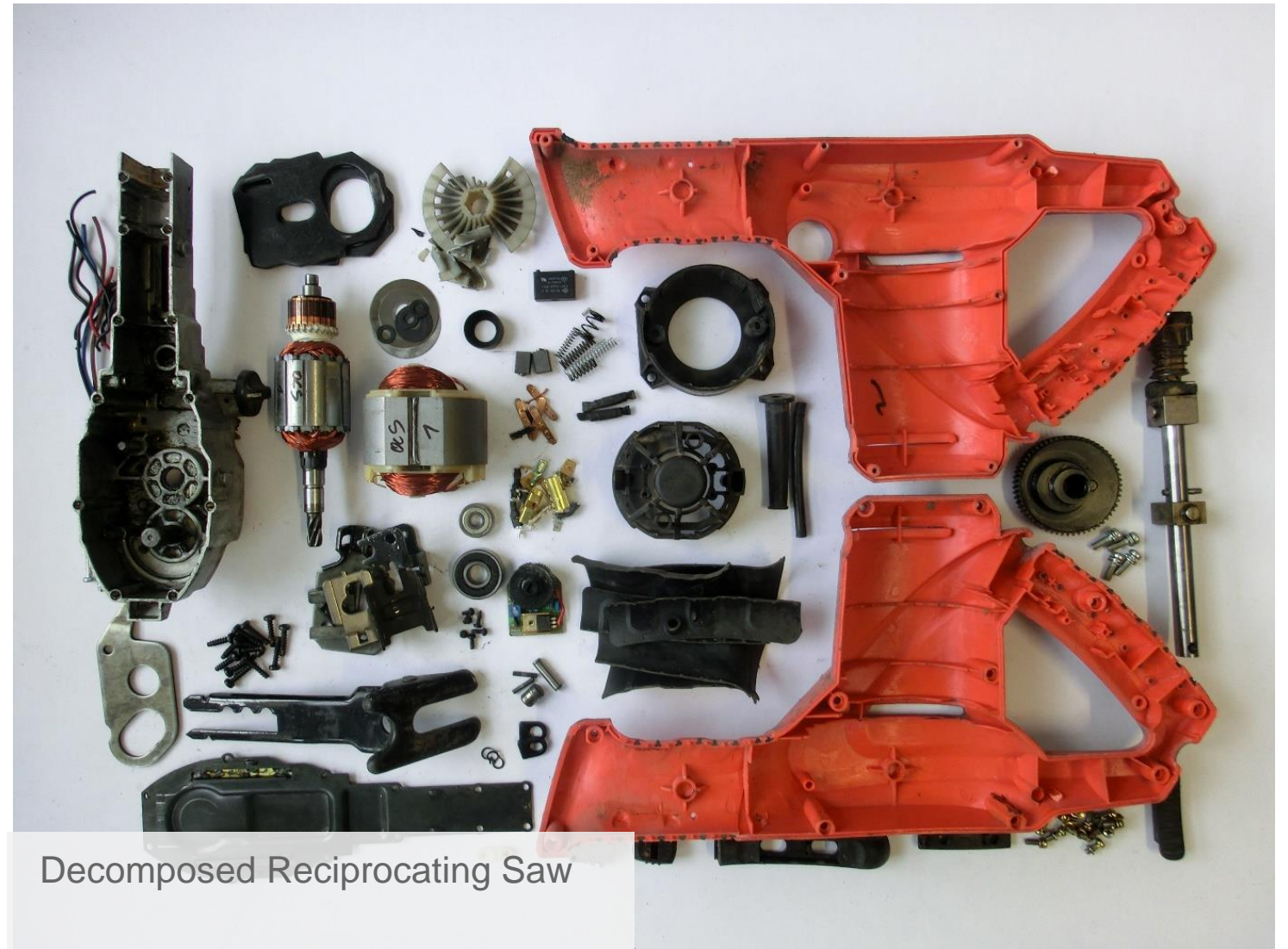
Normal Distribution Plot
(ml-science.com)

RESULTS

MATERIAL ANALYSIS

- ABS earlier times 1990s
- PA6, PA66 with GF 30% - 50%
- Housings Zn alloy and Al alloy
- Steel construction parts
- Copper windings
- EPDM and PB flexible parts
- Bronze bearings
- Brass contacts
- More than 9,700 parts

Stators and Rotors are most massive parts average 35% of whole weight



RESULTS

LCA CALCULATIONS

- 402 individual power tools End of Life (134 pcs. with 3 End of Life)
- T-test (30 categories)
- 6 samples p -value ≥ 0.05



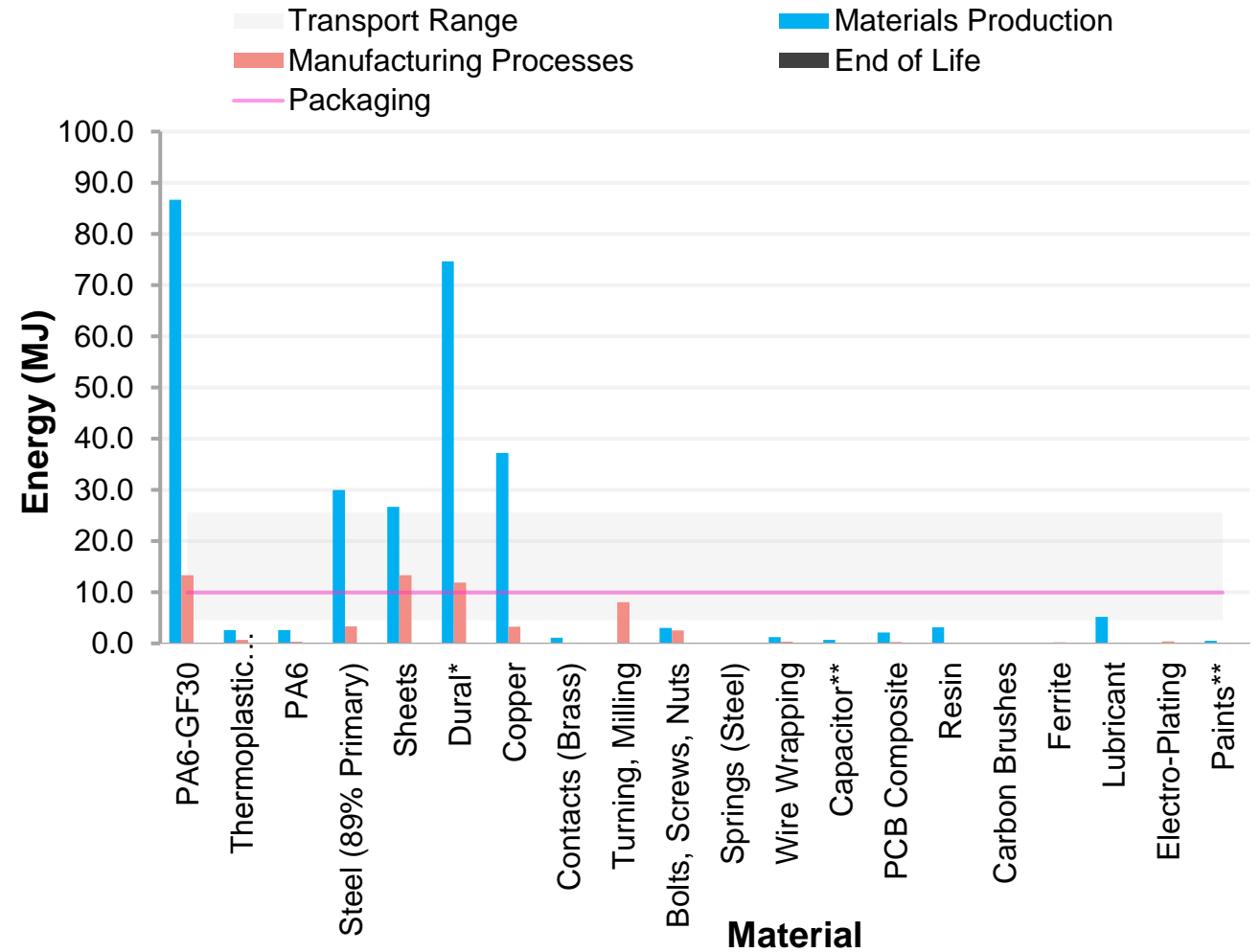
Gearbox of Angle Grinder - Missing lubricant

RESULTS

EOL- LANDFILLING

- All materials was landfilled
- Most plastic 48.9% (BS7)
- Packaging 5.5% of production energy
- Transport 6.5% of production energy
- Production energy ranges from 2.4% to 7.5% of Use Phase

Landfilling – Reciprocating Saw (RS1)

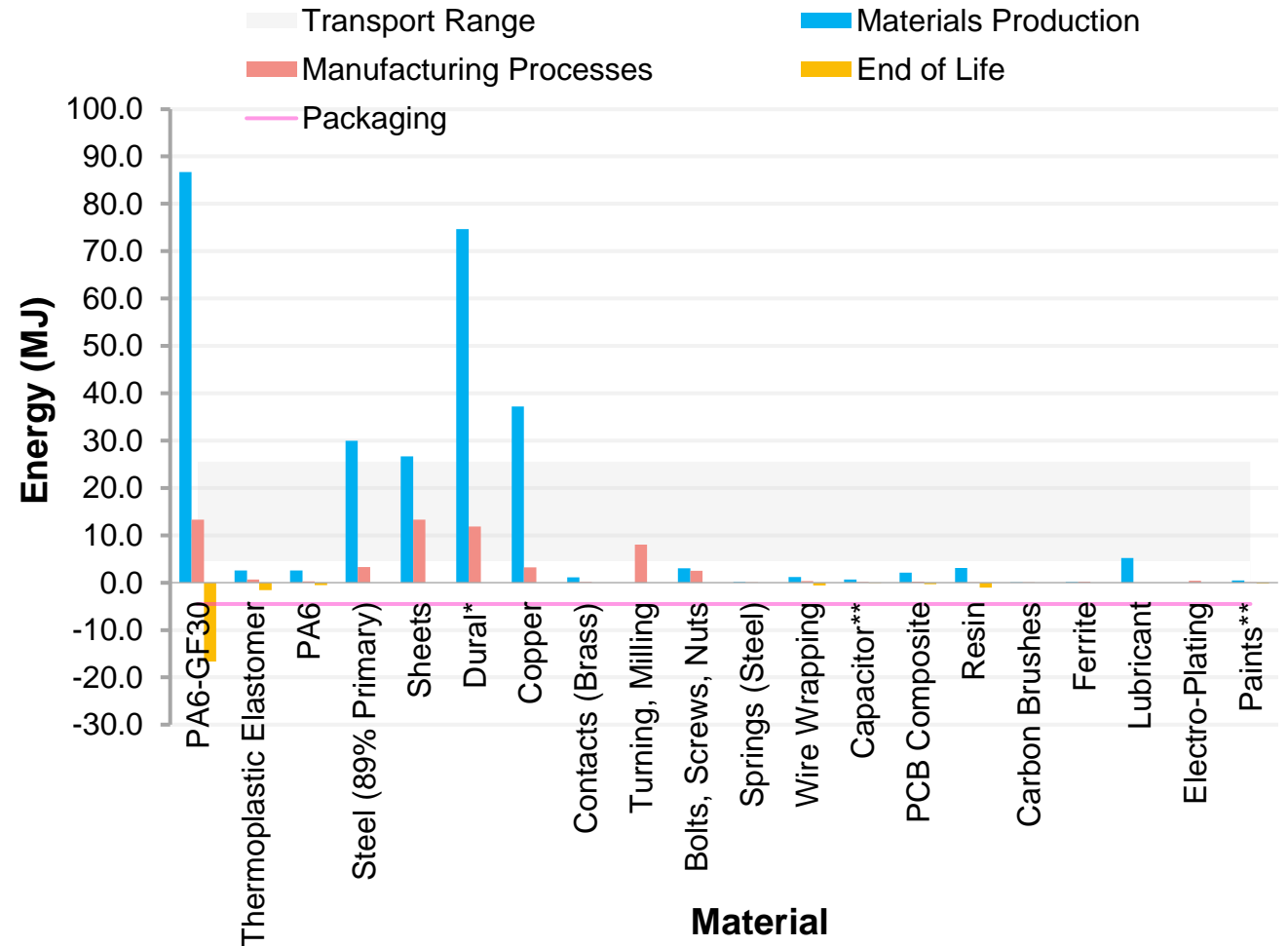


RESULTS

EOL - COMBUSTION

- Only materials with Feedstock share
- PCBs, Plastic, capacitors, paints, parts of GF composite
- Non-combustable parts and trash are landfilled

Combustion – Reciprocating Saw (RS1)

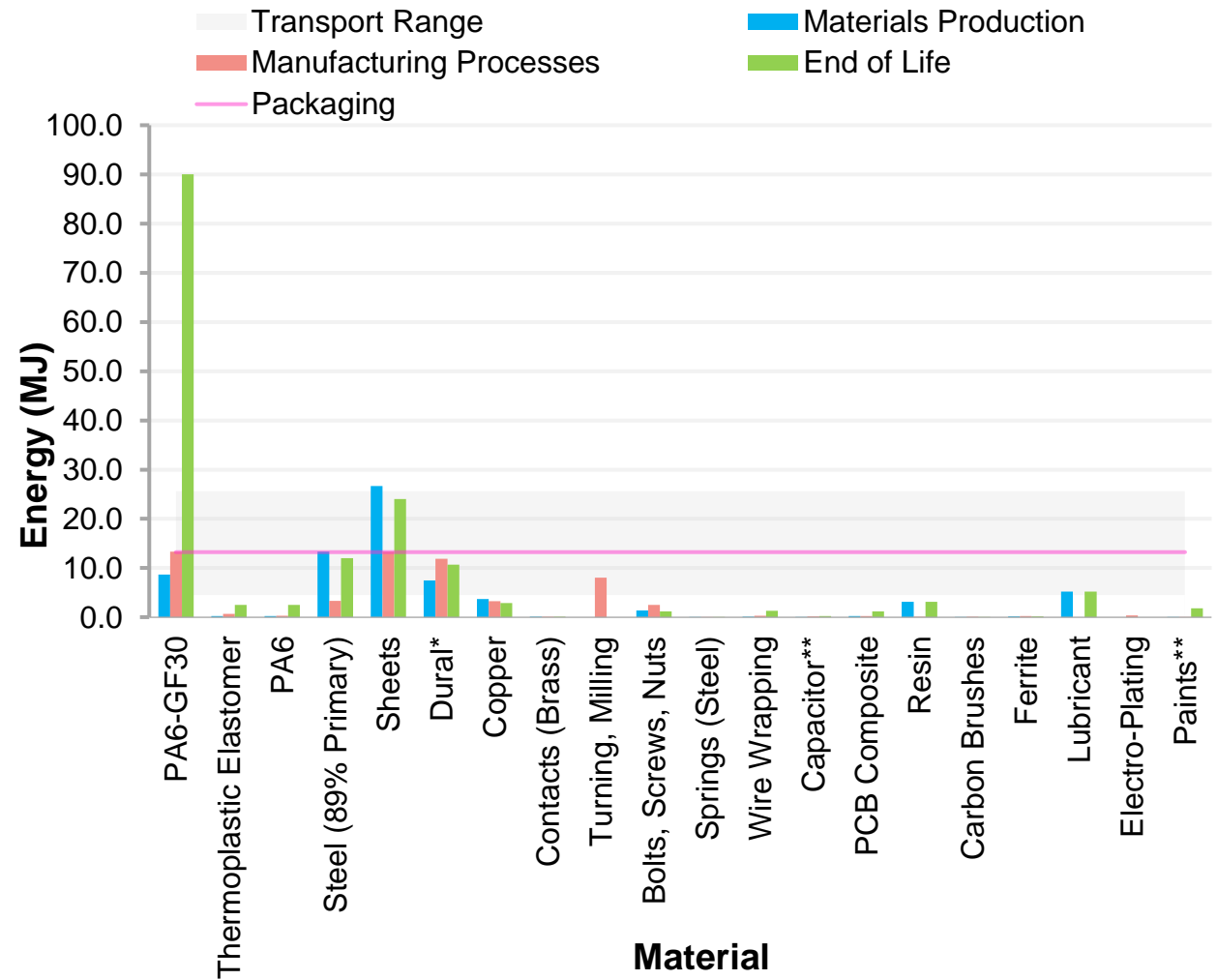


RESULTS

EOL – RECYCLING 90%

- Only materials with Fuel Share
- Added energy Shredding, Separation a Re-melting (added 45 MJ/kg)
- RC90% save max. 32.5% to LF

Recycling 90% – Reciprocating Saw (RS1)

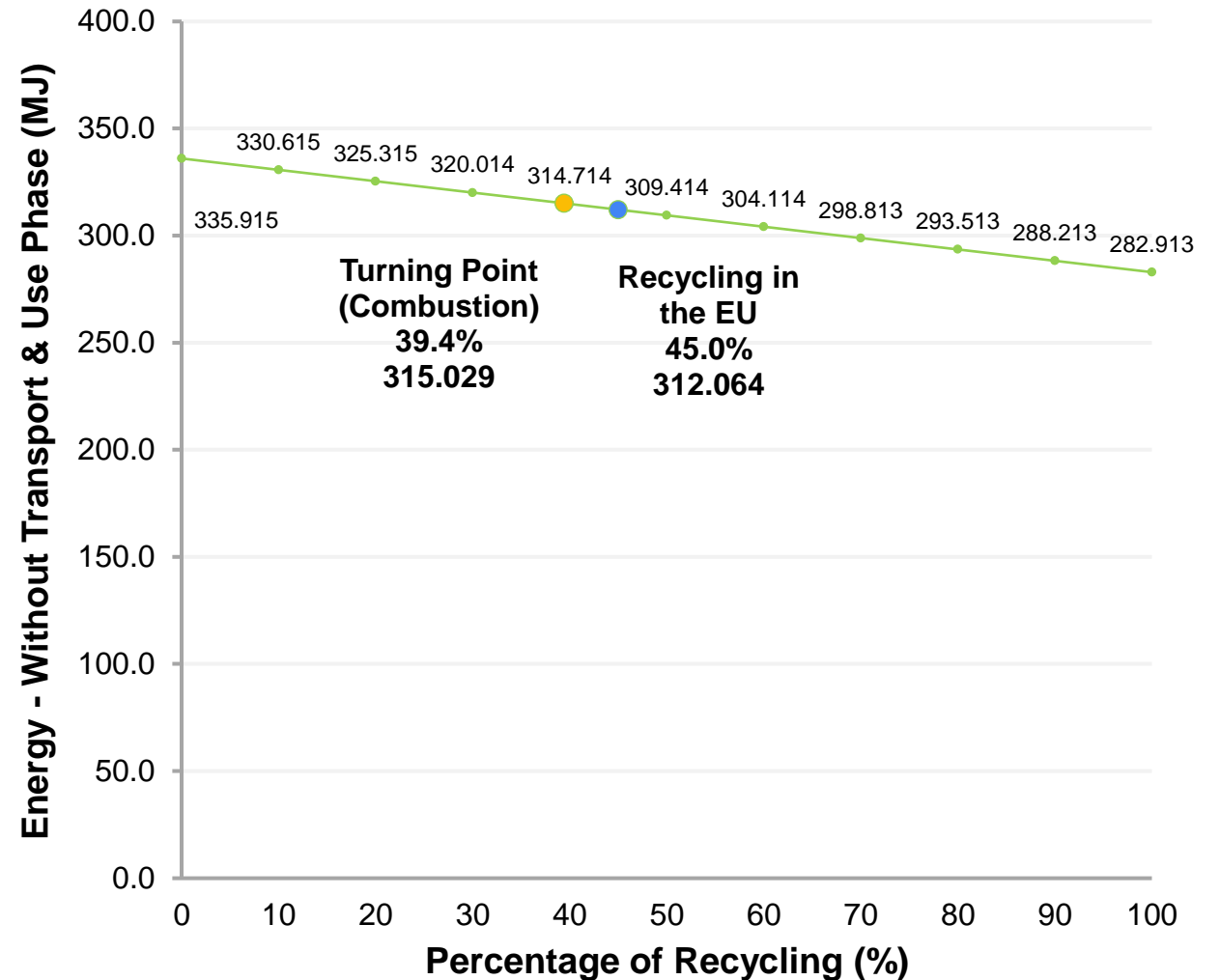


RESULTS

LCA – TURNING POINT

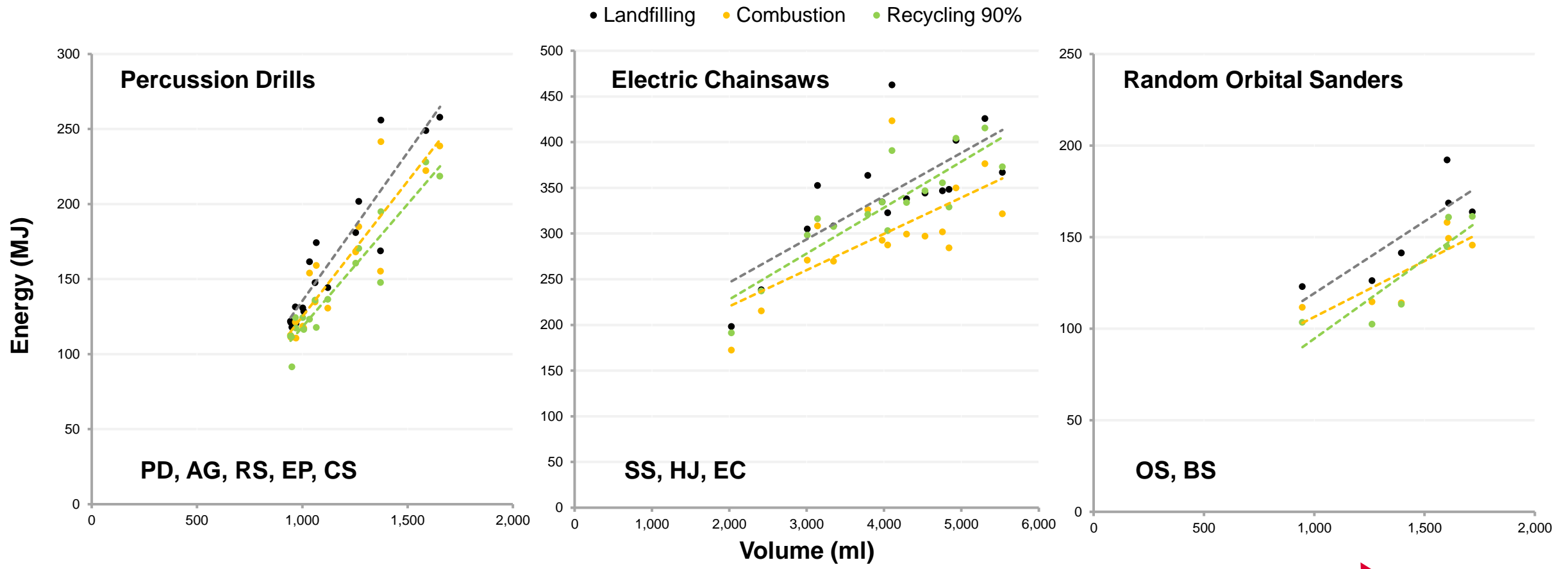
- 45% Recycling (EU demand)
- 47 cases were Combustion > Recycling 45%
- 13 cases positive straight line (power tools with large amount of plastics)
- 45.5% TP cannot be found (RC 0% to 100%)

Turning Point – Reciprocating Saw (RS1)



RESULTS

EOL – ARRANGEMENT OF EOL



RESULTS

LCA SIMULATION

Average values of the cor. coef.

Random Orbital Sanders (OSMJ = 84.1% ± 0.6%)

Sheet Sanders (SSMJ = 65.7% ± 3.6%)

Electric Planers (EPMJ = 78.5% ± 3.8%)

Handle Jigsaws (HJMJ = 76.7% ± 2.0%)

Belt Sanders (BSMJ = 81.2% ± 1.5%)

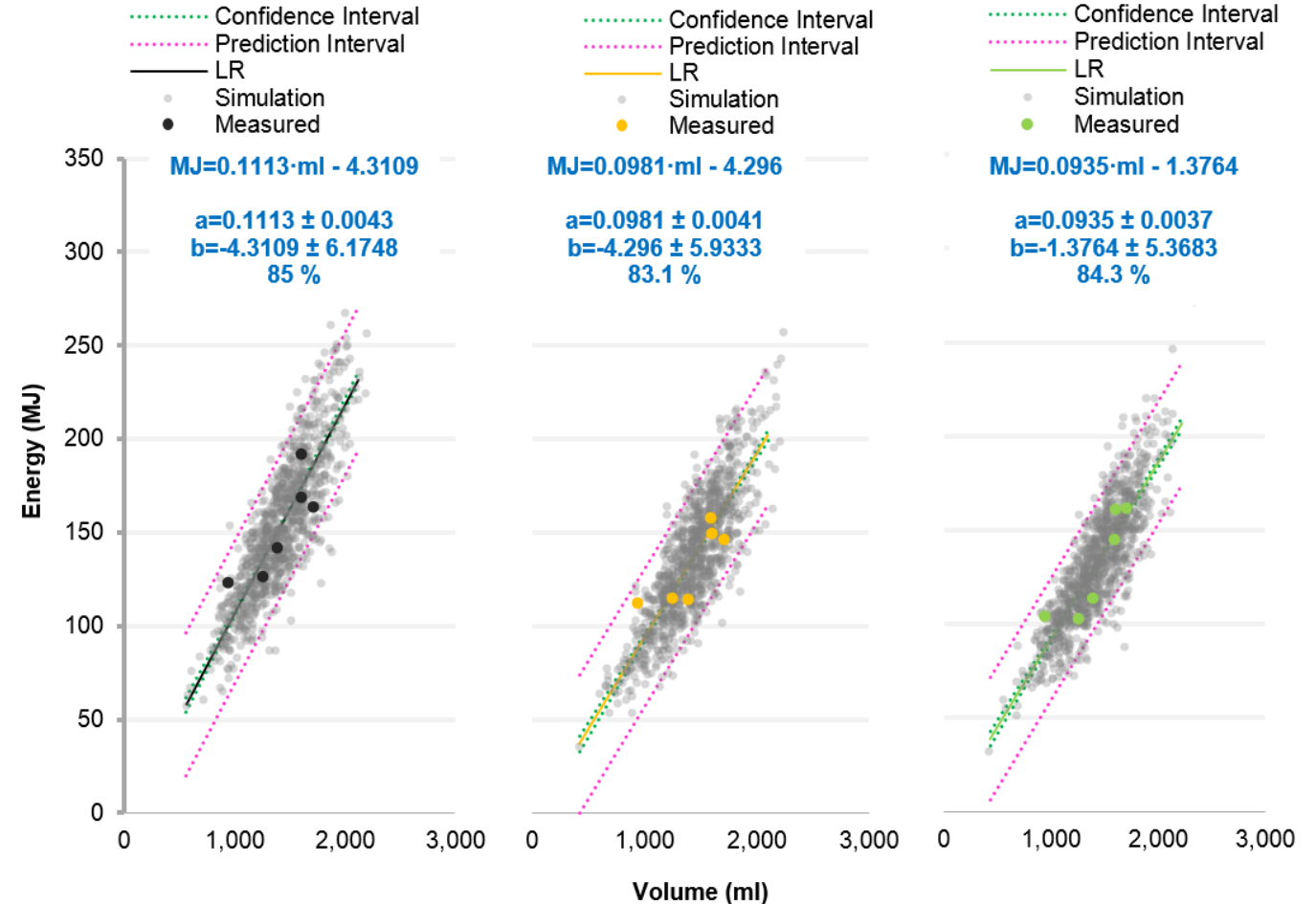
Percussion Drills (PDMJ = 84.4% ± 2.0%)

Circular Saws (CSMJ = 74.6% ± 6.5%)

Angle Grinders (AGMJ = 97.1% ± 0.2%)

Electric Chainsaws (ECMJ = 83.8% ± 2.4%)

Reciprocating Saws (RSMJ = 95.8% ± 0.5%)



Random Orbital Sanders (Landfilling/Combustion/Recycling 90%)

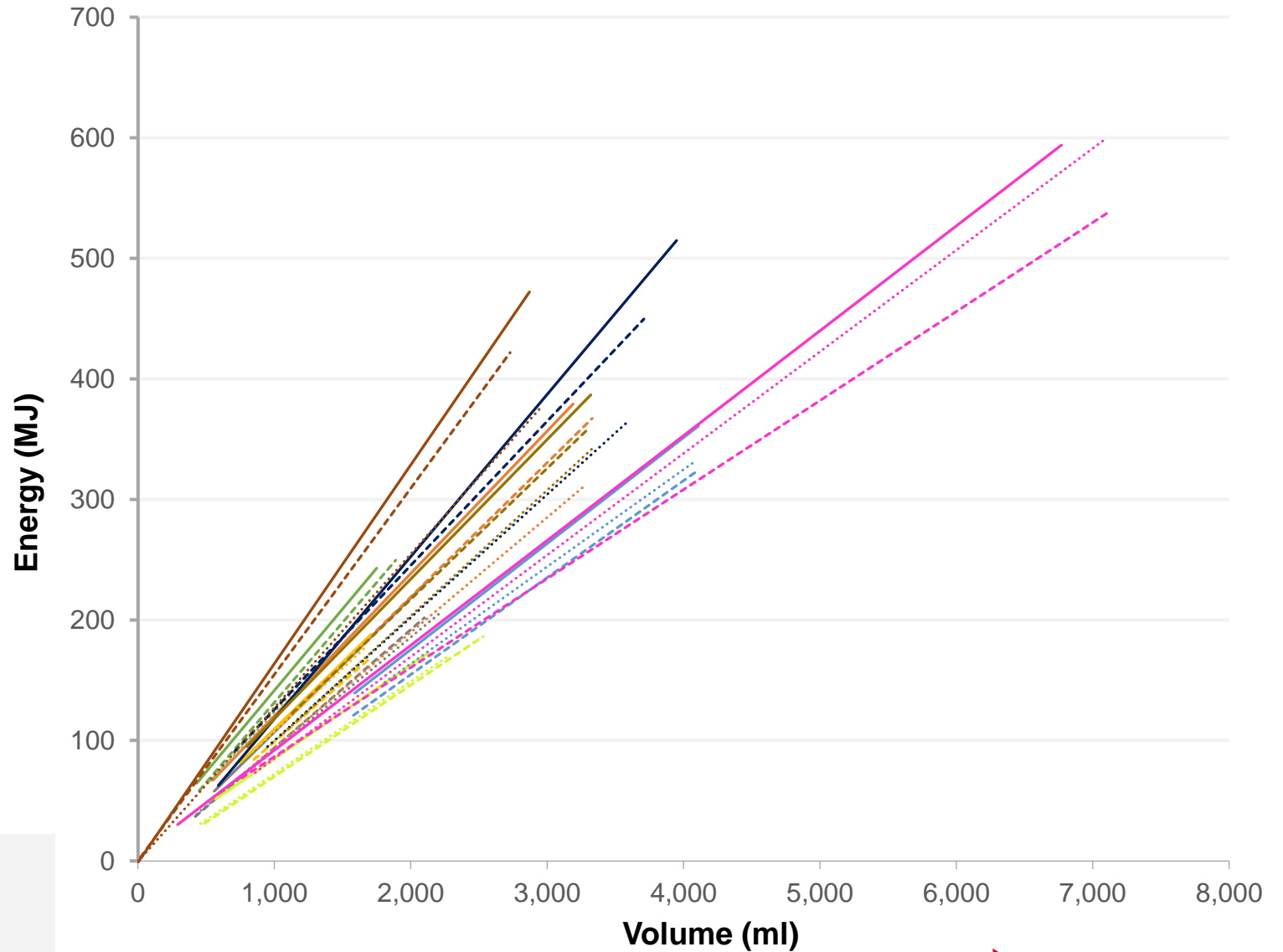
RESULTS

LCA SIMULATION & EQUATIONS

- Energy MJ and kWh
- Sets of 30 equations (3 EoL)

- Energy Classes

Energy Simulation of Power Tools Category
(Landfilling, Combustion & Recycling 90%)



RESULTS

LCA SIMULATION

Energy Classes

E1 (Angle Grinders, Percussion Drills)

E2 (Random Orbital Sanders, Electric Planers,)

E3 (Handle Jigsaws, Circular Saws, Reciprocating Saws)

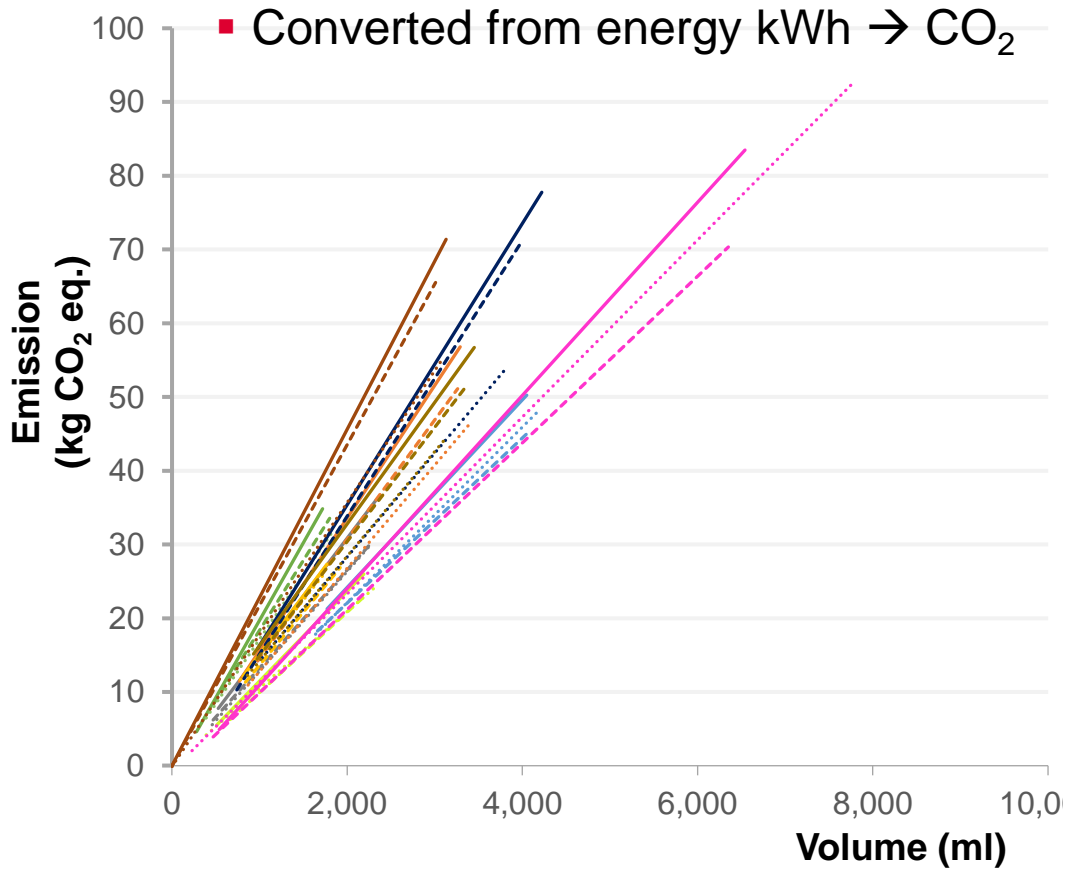
E4 (Sheet Sanders, Belt Sanders, Electric Chainsaws)

- Different order by Volume and Weight Classes

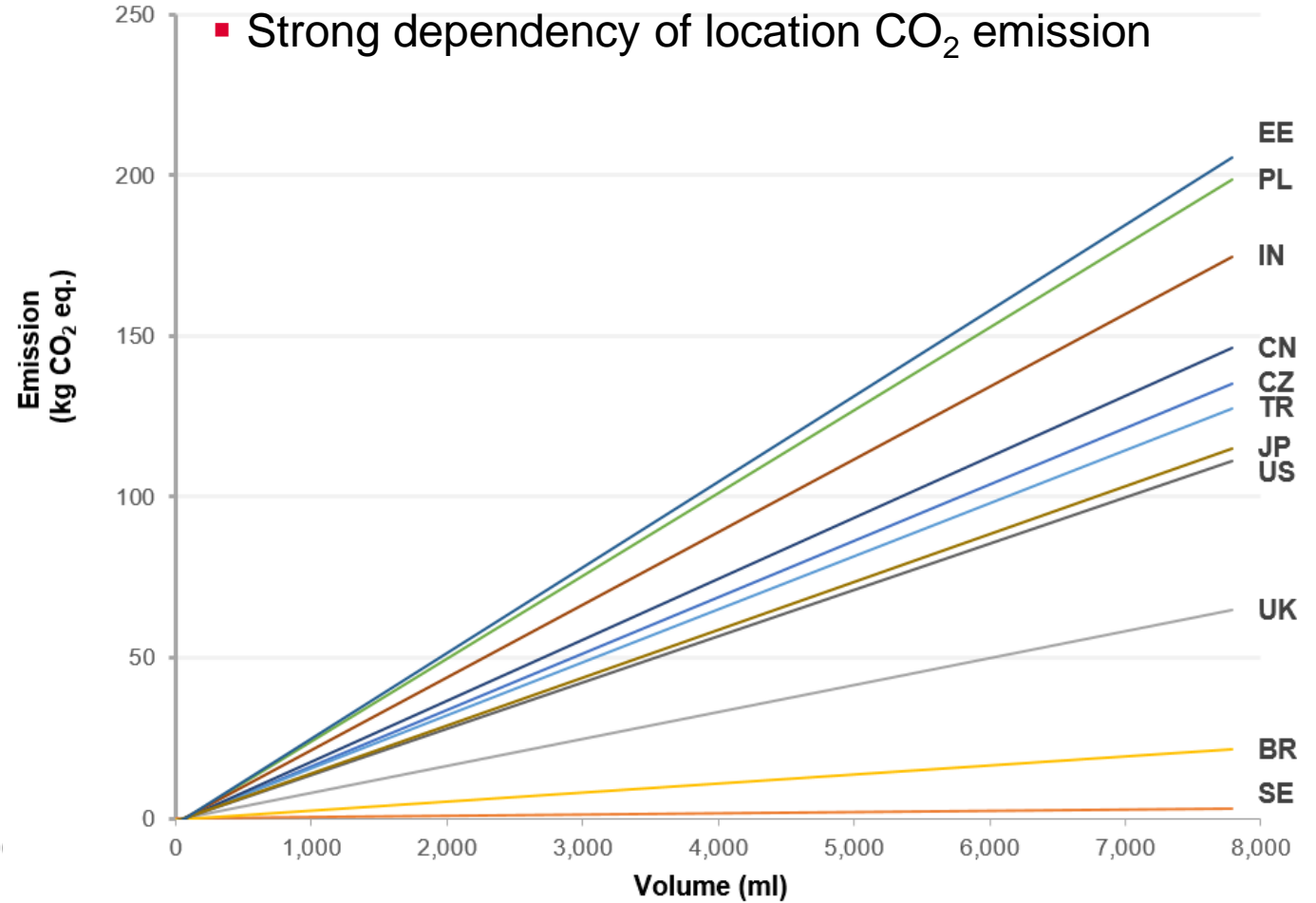


RESULTS

EMISSION KG CO₂ EQ. FOR CATEGORIES OF POWER TOOLS



EMISSION KG CO₂ EQ. PER COUNTRY



RESULTS

APPLICATION OF VEME METHOD



D. Lob

- 115 mm
- 974 ml
- 159-124 MJ



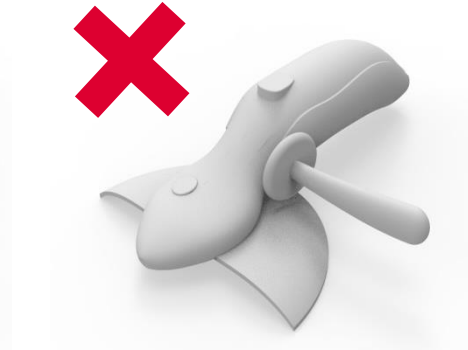
K. Sychrová

- 115 mm
- 820 ml
- 134-104 MJ



A. Matušková

- 125 mm
- 969 ml
- 158-123 MJ



T. Kreidlová

- 125 mm
- 666 ml
- 108-84 MJ



R. Sovják

- 125 mm
- 1,099 ml
- 179-139 MJ

AG 115 mm – volume reducing from 974 ml to 820 ml, savings 15% of energy/emissions

SOFTWARE

APPLICATION OF THE METHOD

Software Properties of VEME

- Quick on-line evaluating
- Calculation of energy and emission CO₂ eq.
- Comparison of energy and emission CO₂ eq.
- Calculation of emission allowances
- End of Life calculation

<http://veme.cz/>



Volumetric Evaluating Method for Ecodesign

DISCUSSION

Material Analysis

- Correct determination of plastic (PVC, TPE, ...)
- Crushing rotors (had to be calculated)

OPM Calculations

- Calculated PCB, Capacitors, V-Belts and Manufacturing processes (Cold vs Hot Rolling)

LCA Calculations

- Same recycling level (all materials)
- Recycling levels are different in EU countries
- Transport range and Use phase

LCA Simulation

- Value of n (iteration) higher than 10,000
- Crossing EoL curves (missing samples)

Next Research

- Enlarged amount of power tools types
- Convert volume properties to weight calculation
- Transform AC to DC motors
- Emission upgrade
- Detailed Transport processes
- Cradle to Gate system method application

Recycling: Theoretical 27%, Calculated 32%

CONCLUSIONS

SCIENTIFIC QUESTIONS

- A. Does the size and type of product affect environmental pollution? **CONFIRMED**
- B. Can the amount of emissions kg CO₂ eq. and energy consumption for production be based only on the volume and nature of the product? **CONFIRMED**

VEME sets the equation for calculating 3 EoL for emissions CO₂ production energy MJ and kWh in defined categories of power tools.

- Unique method for determining environmental impact in early stage of product design
- Easy to use, quantified data from volume of power tools only
- Personalised emissions kg CO₂ eq. from energy mixes of each country or economy
- Energy for transport, packaging and use phase are predictable
- Use for optimising of manufacturing, recycling; ecolabeling, education & **shape optimisation**

LIST OF PUBLICATIONS

2015

SOVJÁK, R.; ONDRA, M.; ZDVIHALOVÁ, M. Method of Mock-up Scanning for Acceleration of Design Process. In Book of Proceedings of 56th International Conference of Machine Design Departments. First. Nitra: Slovak University of Agriculture in Nitra, 2015. s. 229-232. ISBN: 978-80-552-1377-4.

SOVJÁK, R.; ONDRA, M.; ZDVIHALOVÁ, M. Method of Mock-up Scanning for Acceleration of Design Process. Machine Design 56th International Conference of Machine Design Departments. In First. Scholar' s Press, 2015. ISBN: 978-3-639-66914-5.

ZDVIHALOVÁ, M.; ONDRA, M.; SOVJÁK, R. Implementation of brand on industrial products. In Book of Proceedings of 56th International Conference of Machine Design Departments. 1. Nitra: Slovak University of Agriculture in Nitra, 2015. s. 266-271. ISBN: 978-80-552-1377-4.

LIST OF PUBLICATIONS

2016

SOVJÁK, Richard. Ecodesign and its influence on the design of production machines. Brno, 2016. Bachelor thesis. Brno University of Technology.

MALÁTKOVÁ, H.; SOVJÁK, R. Design of Children Prosthetics from Non- traditional Materials. In Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS. Hradec Králové: Magnanimitas, 2016. s. 1455-1461. ISBN: 978-80-87952-17-7.

SOVJÁK, R.; FRIDRICHOVÁ, E. Application of Non-traditional Materials in Design of Machine Tools Control Panel. In Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS. Hradec Králové: Magnanimitas, 2016. s. 1764-1768. ISBN: 978-80-87952-17-7.

ZDVIHALOVÁ, M.; SOVJÁK, R. The Possibilities of Using Ergonomic Methods in Design Practice. In Book of Proceedings of 57th International Conference of Machine Design Departments. First. Pilsen: University of West Bohemia in Pilsen, 2016. s. 405-410. ISBN: 978-80-261-0609-8.

LIST OF PUBLICATIONS

2016

SOVJÁK, R. Summary of Eco-Design Tools for Industrial Designers. In Book of Proceedings of 57th International Conference of Machine Design Departments. First. Pilsen: University of West Bohemia in Pilsen, 2016. s. 399-404. ISBN: 978-80-261-0609- 8.

SOVJÁK, R. Designing Industrial Products from Non-traditional Materials. In Reviewed proceedings of the International Scientific Conference on MMK 2016 INTERNATIONAL MASARYK CONFERENCE FOR PH.D. STUDENTS AND YOUNG RESEARCHERS. Hradec Králové: Magnanimitas, 2016. s. 1445-1454. ISBN: 978-80-87952-17-7.

2017

SOVJÁK, R. Studying Knowledge about Eco-design Tools at Department of Industrial Design, Brno University of Technology. GRANT Journal, 2017, roč. 5, č. 2, s. 72-75. ISSN: 1805-0638.

SOVJÁK, R., FRIDRICHOVÁ, E., Concepts of Machine Tools Created by Students at Department of Industrial Design, Brno University of Technology. The SGEM Vienna Conference, 2017

LIST OF PUBLICATIONS

2018

SOVJÁK, R. Volumetric Methodology for the Determination of CO2 Emissions and Energy Requirements for the Production of Products at the Early Stage of Product Design, NORDSCI Social, Sciences Conference, July 17 - 19 2018, Helsinki, Finland

SOVJÁK, R., FRIDRICHOVÁ, E., Alternation of an Existing Product Using Environmentally Friendly Materials, SGEM Social, Sciences Conference, 24 Aug-2 Sept 2018, Albena, Bulgaria

FRIDRICHOVÁ, E., SOVJÁK, R., Design Study of Indoor Flower Pots with an Emphasis on their Added Value, SGEM Social, Sciences Conference, 24 Aug-2 Sept 2018, Albena, Bulgaria

HOMOLA, T.; SOVJÁK, R.; Homola Tomáš Bc., Hornoměstská 113/65, Velké Meziříčí, 59401, CZ Vysoké učení technické v Brně, Antonínská 548/1, Brno, 60190, CZ: Krbová kamna. 37156, průmyslový vzor. (2018)

LIST OF PUBLICATIONS

2021

SOVJÁK, Richard. Design and Ergonomics of Hand Tools. Brno, 2021. Master's thesis. Brno University of Technology, Department of Manufacturing Technology and Management of Industry.

2022

SOVJÁK, Richard, Marie TICHÁ and Eva FRIDRICHOVÁ. The Volumetric Method Describing the Life Cycle of Power Tools during Their Production with Different Ends of Life. *Sustainability*. 2022, 14(3). ISSN 2071-1050. Available on: doi:10.3390/su14031498.

IF = 3,251

Thank you for your attention

Richard Sovják, Ing. et Ing.

richard.sovjak@vut.cz



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www.ustavkonstruovani.cz

QUESTIONS AND COMMENTS (Q&C)

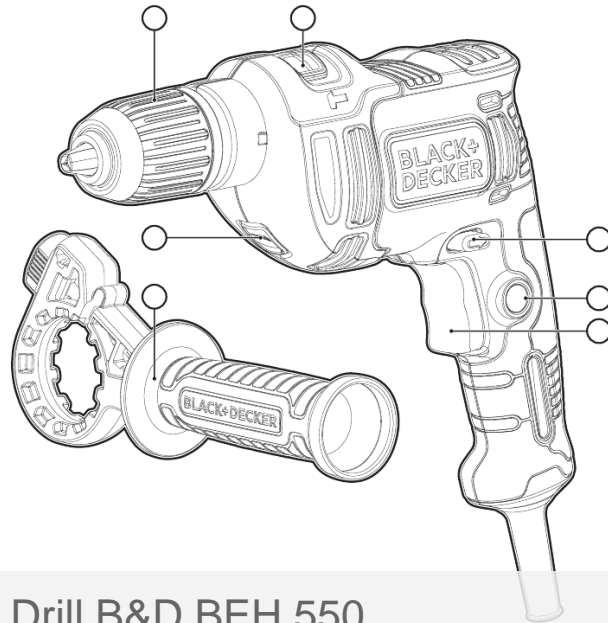
REVIEWER – doc. Ing. Lydia Sobotová, PhD.

1. How complicated do you think it is to correctly determine the material of individual components and parts of products if you do not have all the information about them available, and you do not have this information. In your opinion, what other types of software could be used?
2. What do you think is biggest problem with eco-design of products?
3. It is possible to use your methodology for other types of products, e.g. White goods, computers, or other groups of products?

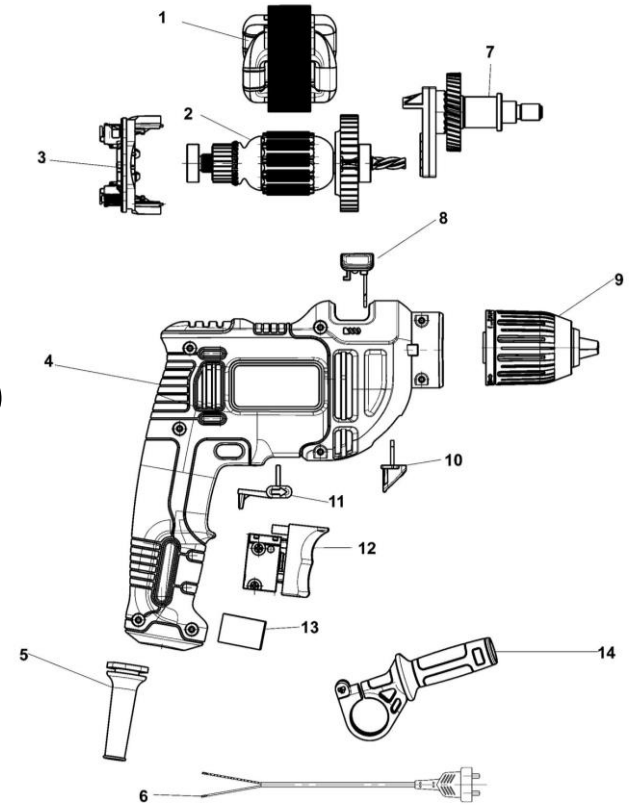
QUESTIONS AND COMMENTS (Q&C)

Q1: MISSING INFORMATION ABOUT USED MATERIALS

- Missing data → low accuracy
- Quantitative → Qualitative
- Calculation with Pareto law
- Calculation with ABC analysis
- Limited OpenLCA



Drill B&D BEH 550
(bruksanvisni.ng, sparepartsworld.co.uk)



QUESTIONS AND COMMENTS (Q&C)

Q2: BIGGEST PROBLEM WITH ECO-DESIGN PRODUCTS

„Human and human behavior that understands ecological possibilities and limits“

- Eco-design is an **instrument not strategy**
- Depends on the company strategy and type of goods/services

- Use and afteruse phase
- Reducing consumption and pollution/microplastics
- High interrelationship between phases

- **Production is greatest challenge of all phases**

Sources/Energy/Waste



QUESTIONS AND COMMENTS (Q&C)

Q3: APPLICATION FOR OTHER TYPES OF PRODUCTS

RANGE OF SAMPLES

- Refrigerators size up to 90 cm (6 pcs.)
 - Refrigerators size up to 200 cm (16 pcs.)
 - Microwaves (9 pcs.)
 - TVs (9 pcs.)
 - Laptops (9 pcs.)
-
- Calculated with ABC analysis



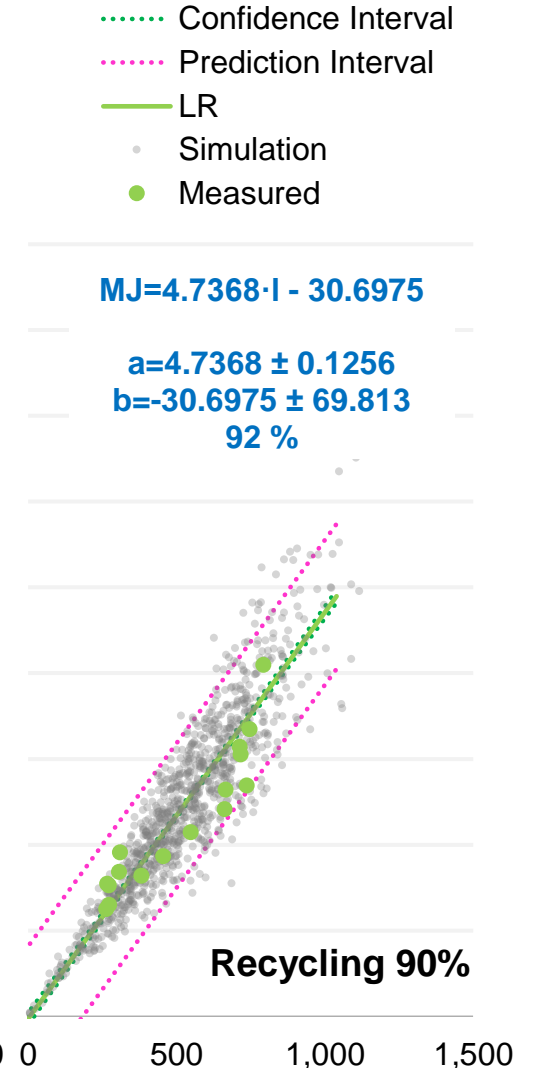
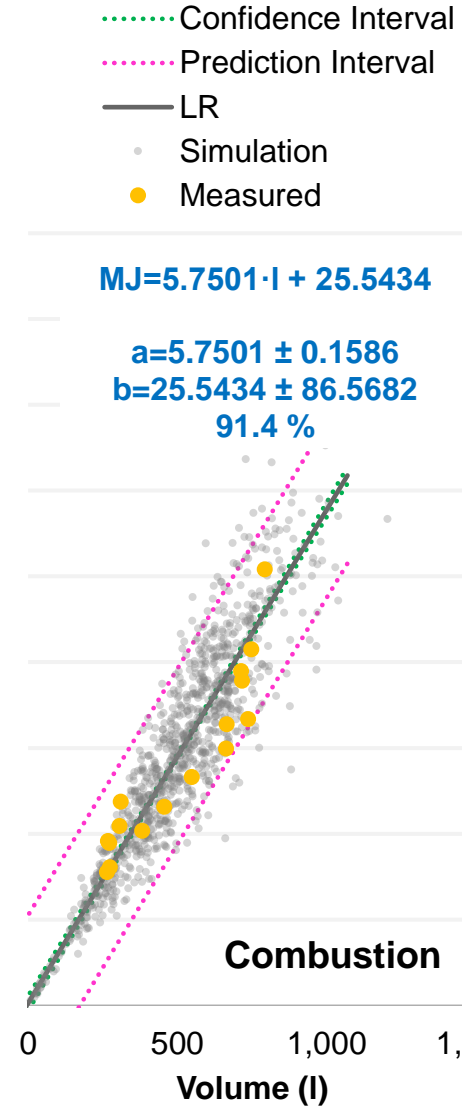
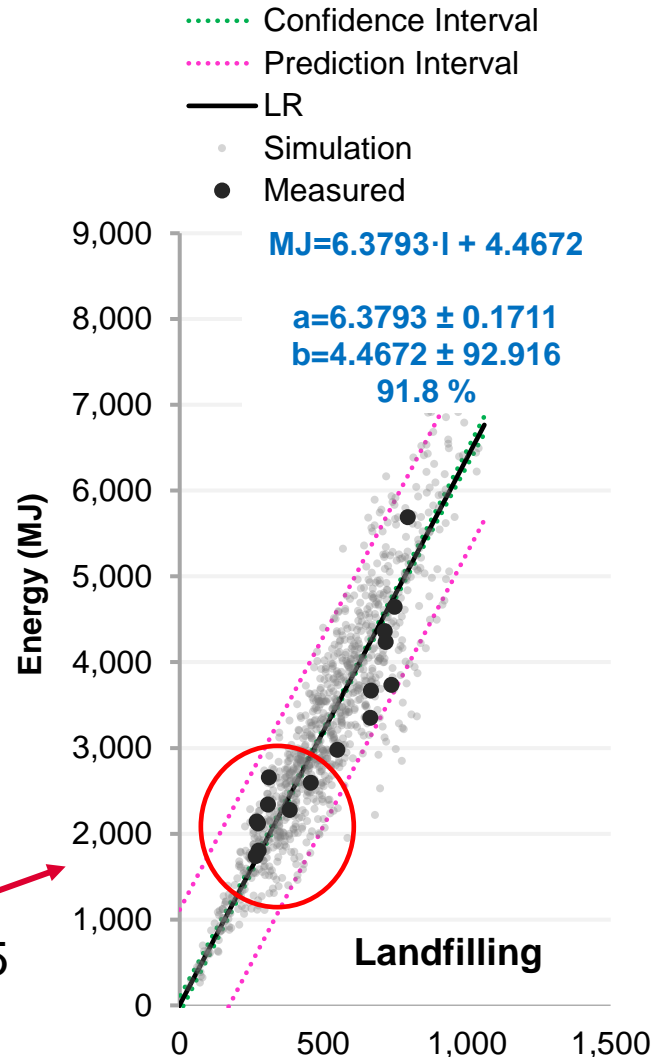
LCA – Landfilling
(datart.cz)

Q3

REFRIGERATORS

- Volume 264 l to 793 l
- Weight 28 kg to 90 kg
- Refrigerators size up to 200 cm (16 pcs.)
- Steel/ABS/Copper
- Max. 5,692 MJ
- Size up to 90 cm $r_{xy} = 0,55$

LCA - Refrigerators size up to 200 cm

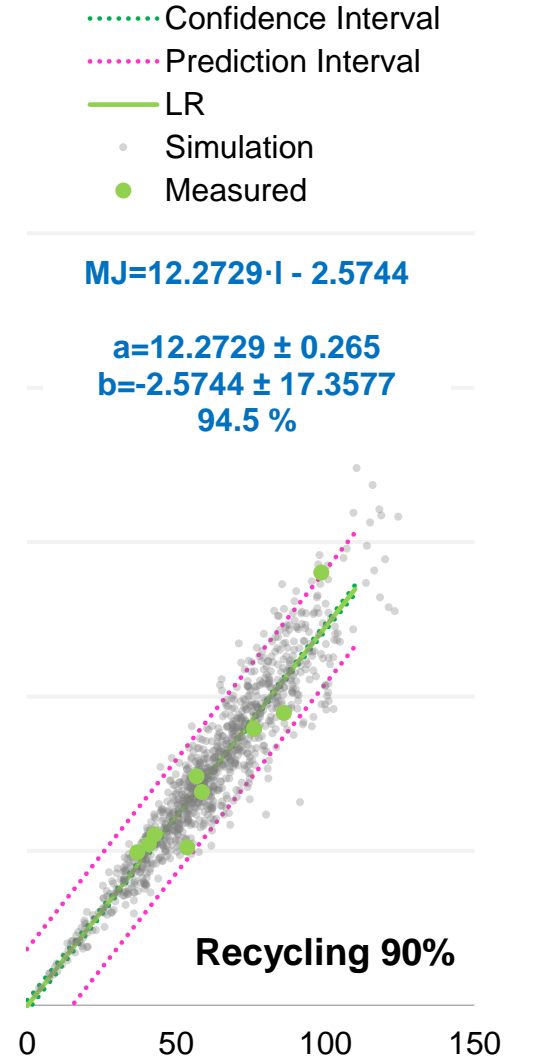
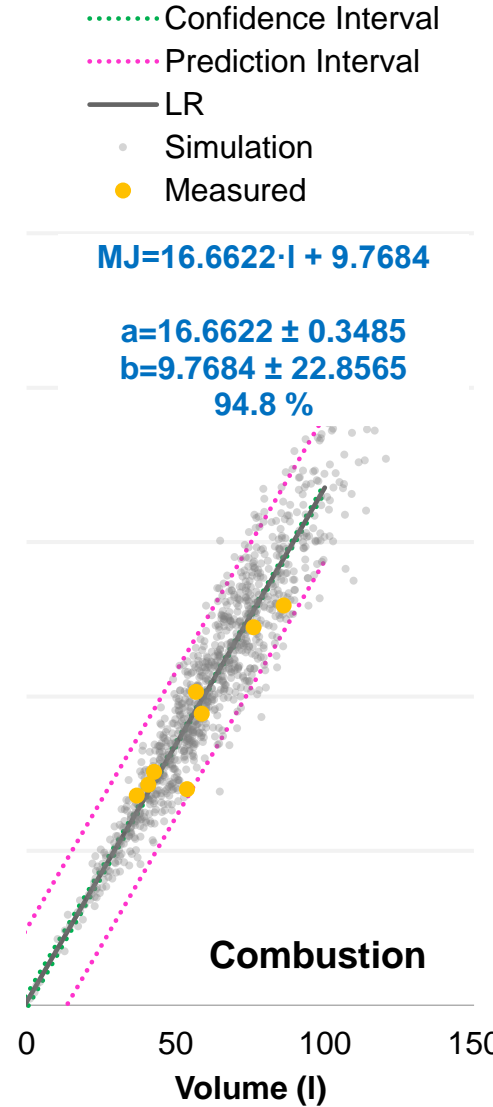
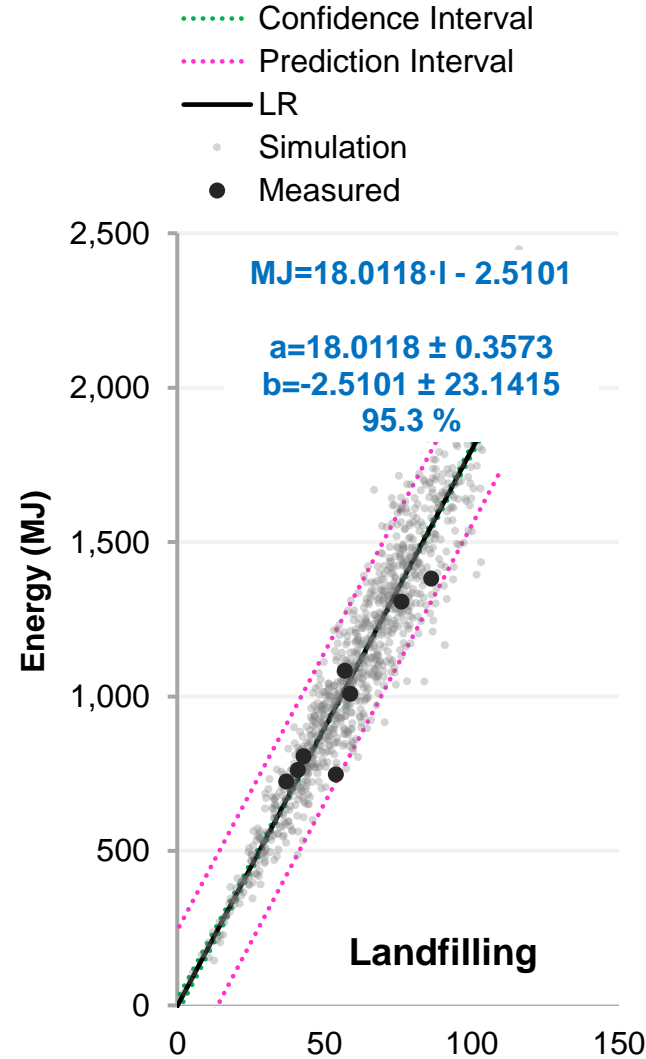


Q3

MICROWAVES

- Volume 36 l to 98 l
- Weight 9 kg to 27 kg
- Samples (9 pcs.)
- Steel/PA/Copper
- Max. 2,046 MJ

LCA - Microwaves

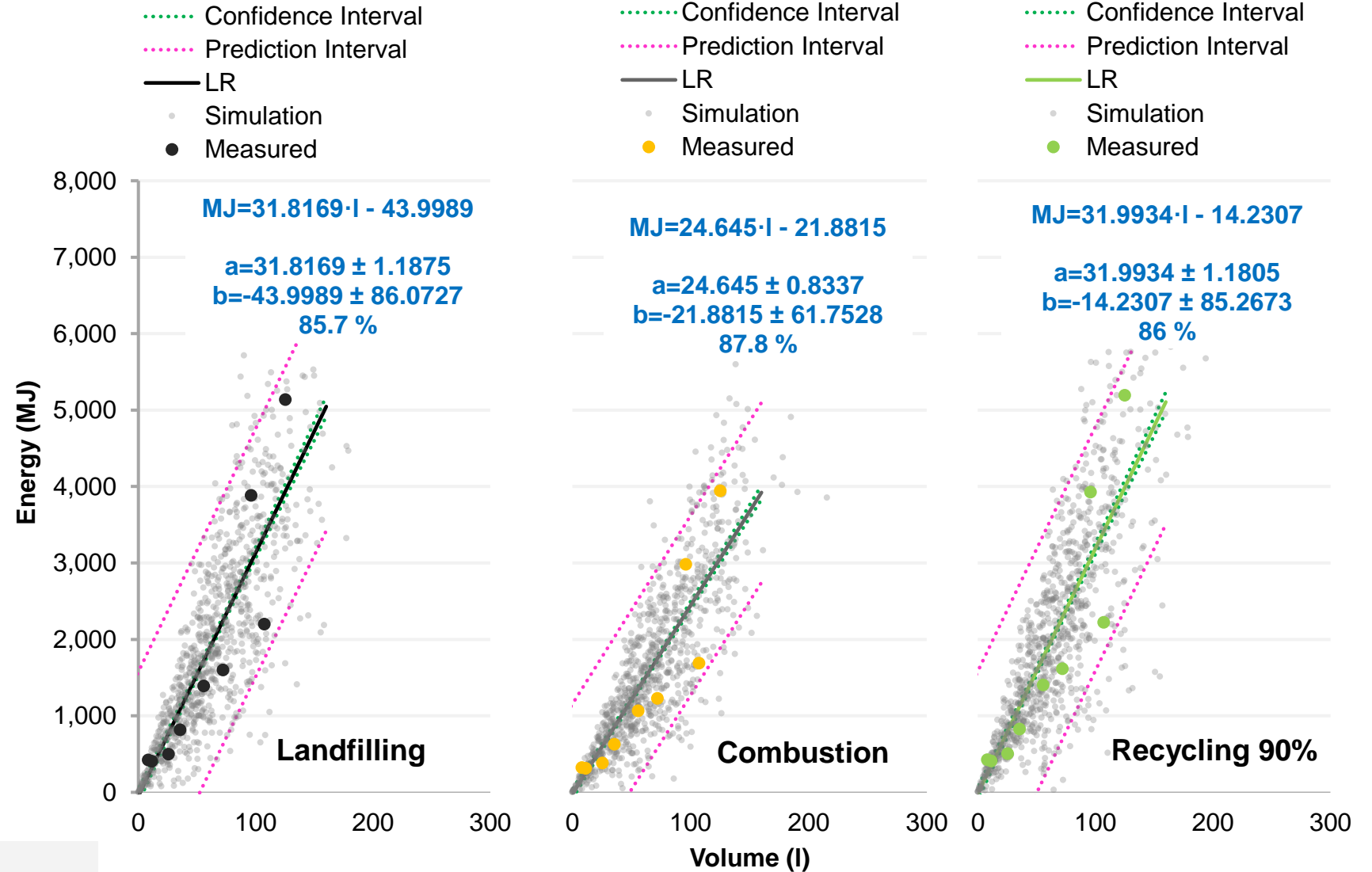


Q3

TVS

- Volume 8 l to 125 l
- Weight 3 kg to 40 kg
- Samples (9 pcs.)
- PC/PCB/Steel
- Max. 5,137 MJ

LCA - TVs

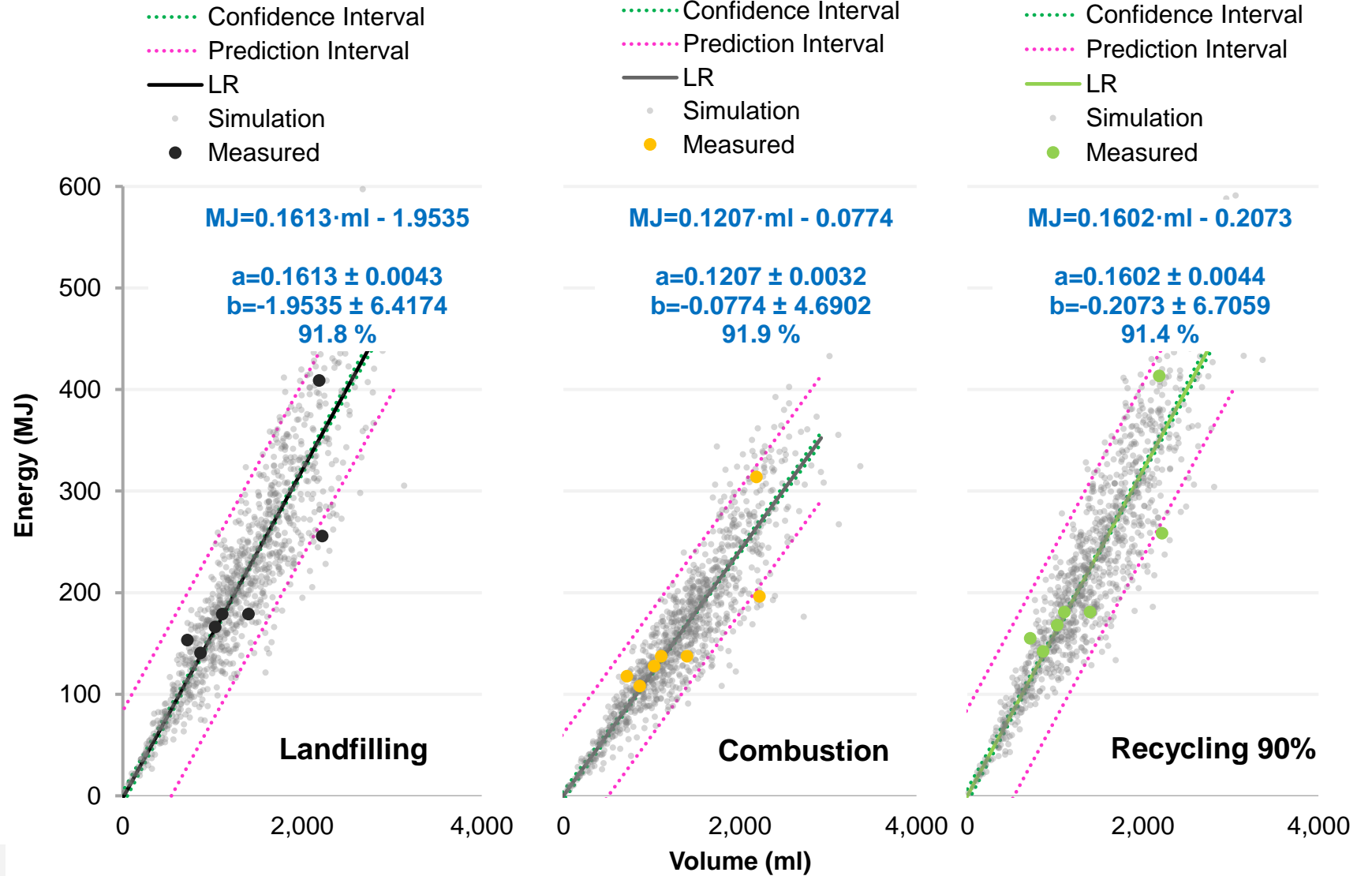


Q3

LAPTOPS

- Volume 0,7 l to 2,2 l
- Weight 1 kg to 3,2 kg
- Samples (9 pcs.)
- PC/PCB/Steel
- Max. 408 MJ

LCA - Notebooks



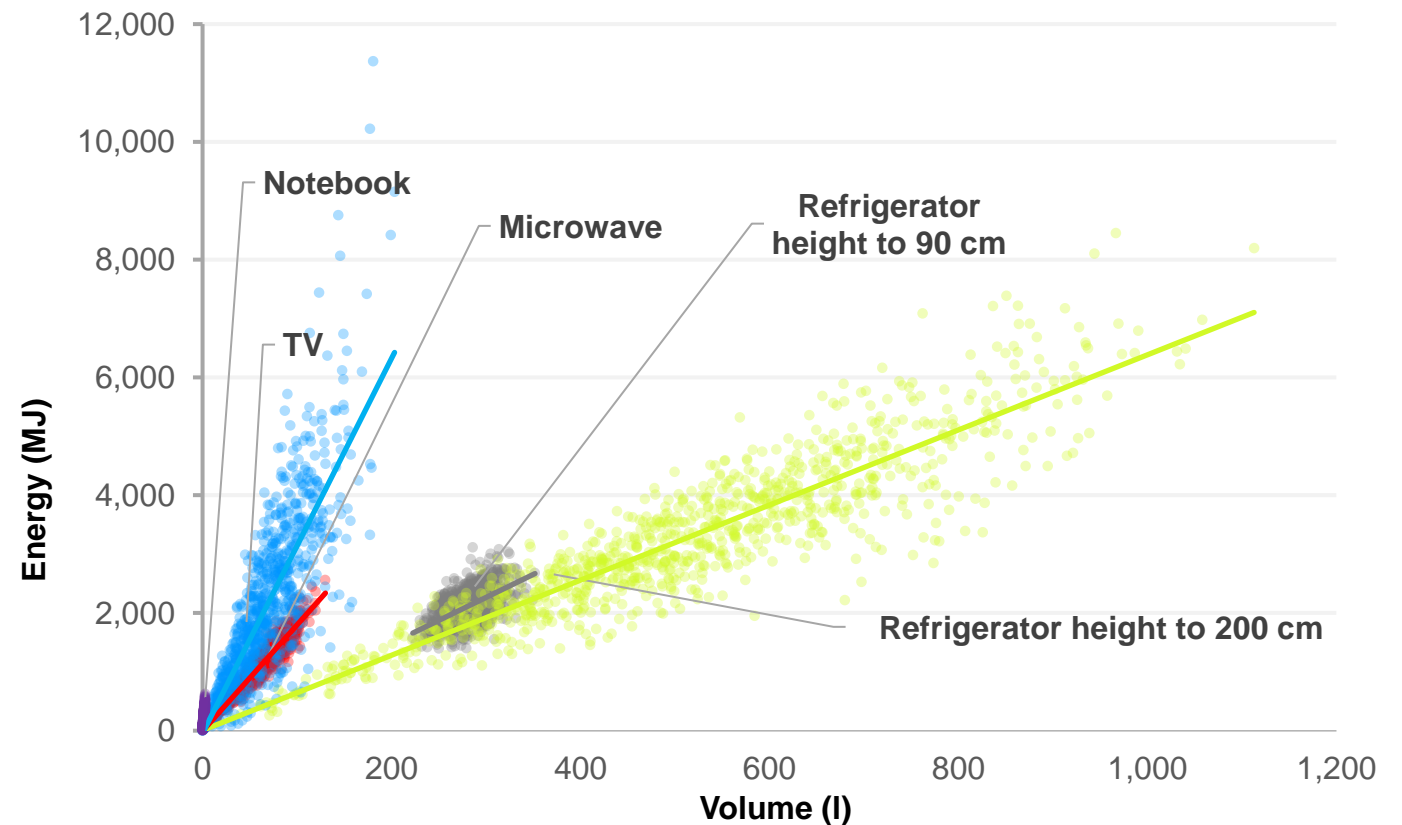
QUESTIONS AND COMMENTS (Q&C)

Q3: APPLICATION FOR OTHER TYPES OF PRODUCTS

RESULTS

- Founded dependency of volume/energy
- Calculated from LF, CM, RC
- Same rules as for power tools
- **Problem with small range of volume and large dispersion of energy**

LCA – Landfilling (Household samples)



QUESTIONS AND COMMENTS (Q&C)

REVIEWER – FH-Prof. Mag. Dr. Günther Grall

1. The list of deconstructed power tools could have been more detailed and the improvement and changes over that long production-period of investigated power tools would have been interesting.
2. Since the use phase is calculated with one factor of 1,000 hours for every product, it may be interesting to do some equations with other forms of usage, for example tools for private users with much less time of usage during life span.

QUESTIONS AND COMMENTS (Q&C)

Q1: INVESTIGATION OF POWER TOOLS SAMPLES IN 29 YEARS PERIOD



Historical Power Tools



Analysed Power Tools



MATERIALS PROFIT

- Aluminium parts (gear boxes, covers)
- Holder from Zn alloy
- Application composite materials (gears)
- Ceramics PCB

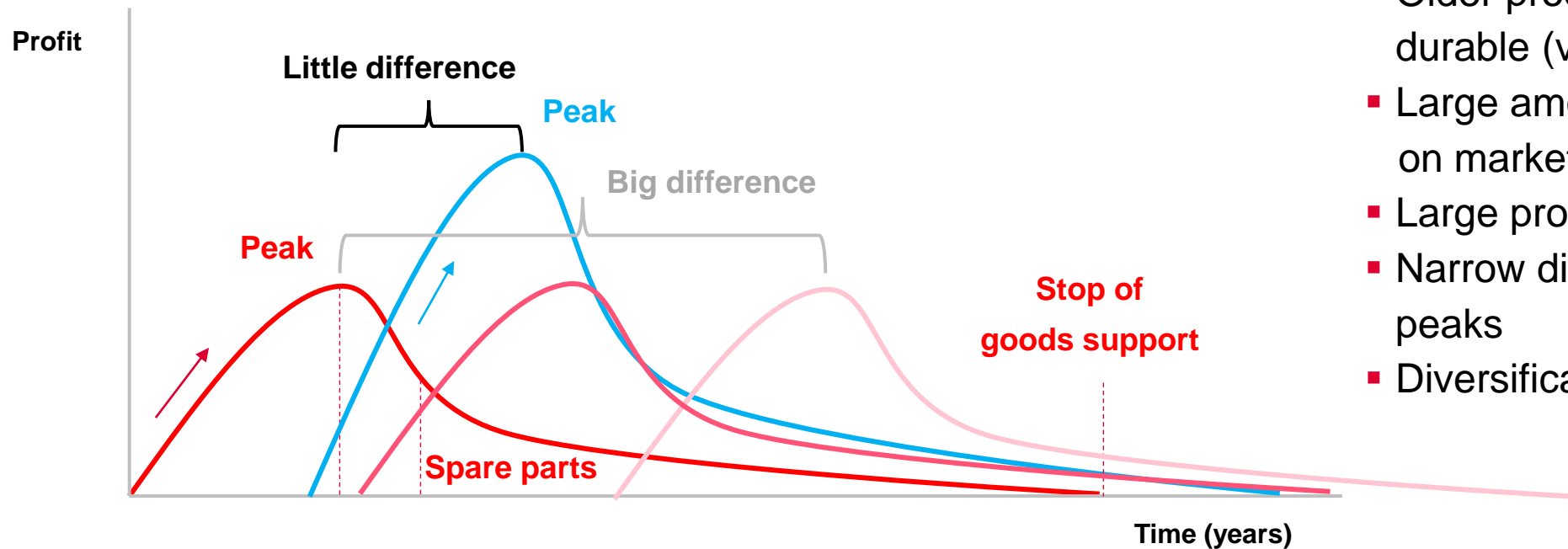


CURRENT PROBLEMS

- Complicated recycling plastic +GF
- Electromotors (problem with winding)
- **Controlled life cycle (durability, fails after guarantee)**

QUESTIONS AND COMMENTS (Q&C)

Q1: INVESTIGATION OF POWER TOOLS SAMPLES IN 29 YEARS PERIOD



- Older products are more durable (verified materials)
- Large amount of goods on market
- Large profits for companies
- Narrow difference between peaks
- Diversification on the market

LCA – economical view on to controlled life cycle

QUESTIONS AND COMMENTS (Q&C)

Q2: USE PHASE (USAGE)

- Variability of Use Phase
- Different Impacts on private or industry users
- High energy consumption of motors/engines



Bottle
(thelist.com)



USB Discs
(usbmedia.cz)



Electric Motors
(eduk.sk)

QUESTIONS AND COMMENTS (Q&C)

Q2: USE PHASE (DISCS, BARS, ...)

- Different Disc = Different Use Phase
- Load = Consumption of energy
- Working Tact
- Materials
- No-load running
- Effectivity of production

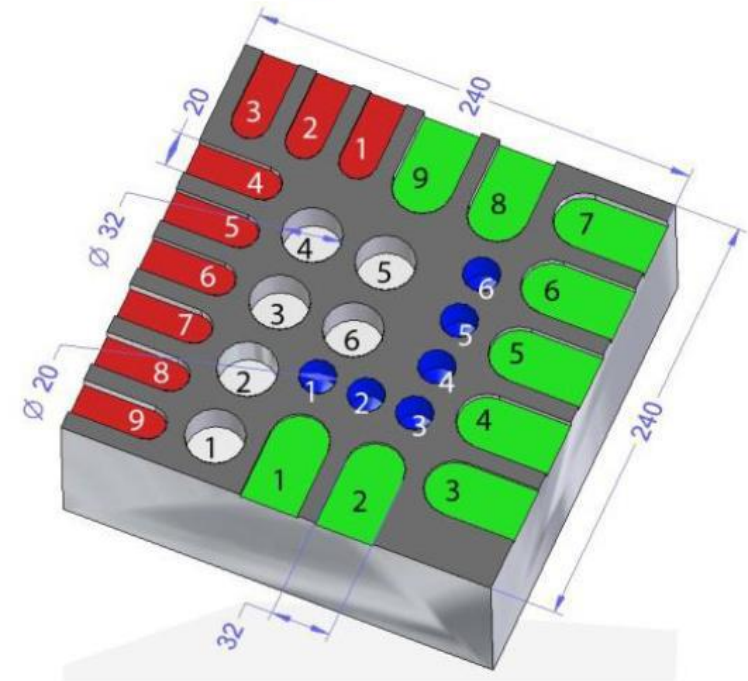


Grinder Disc
(anglegrinder101.com)

QUESTIONS AND COMMENTS (Q&C)

Q2: USE PHASE (APPROACHES FOR SETTING CONSUMPTION)

- Set by estimation
- Set from statistical data
- Software simulation
- Measured total consumption
- Measured peripheries
- Measured by defined workpiece
(JIS TS B 0024:2010)

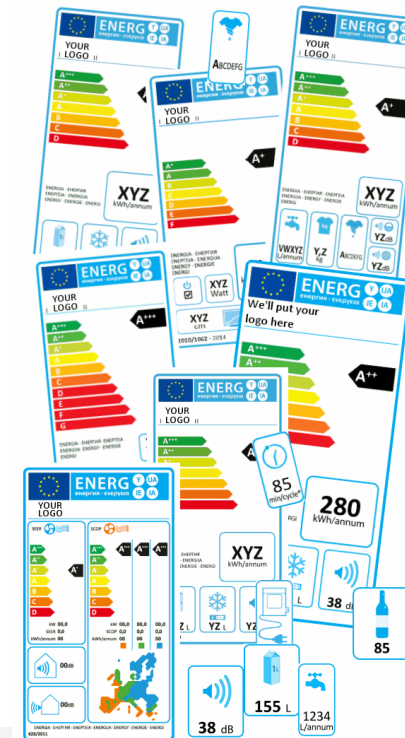


Standardised workpiece
(*tu.berlin*)

QUESTIONS AND COMMENTS (Q&C)

Q2: USE PHASE (POWER TOOLS)

- Different power tools (variability of use phase)
- Set estimation
- Missing information about use phase (Energy labelling)
- The range correspond with used OPM method
- Use Phase 90% to 99% of products
- Calculated from power consumption



Energy labelling
(euenergylabels.com)