Automotive Circle International

”Strategies in Car Body Engineering 2013“

Innovation Alliance Green Carbody Technologies - *InnoCaT*®
- an energy and resource driven approach

Prof. Matthias Putz, Fraunhofer IWU Chemnitz

March 20 2013, Bad Nauheim

Innovations-Allianz Green Carbody Technologies

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The FRAUNHOFER IWU

An Institute of the Fraunhofer-Gesellschaft

FRAUNHOFER IWU 20 Jahre IDEENFABRIK

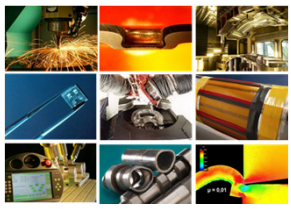
Short Profile

- ~ 510 employees
- 29 Mio € for project researching (2012), ~50% industry
- 4 000 m² testing field
- Institute branches in **Chemnitz,** Dresden, Augsburg

R&D competency **“Resource-Efficient Production“**


IWU testing fields


IWU Campus Chemnitz



Fields of Research

- Machine tools
- Mechatronics
- Lightweight structures
- Cutting technologies
- Forming technologies
- Joining and assembly technologies
- **Production management**

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INNOVATION ALLIANCE "GREEN CARBODY TECHNOLOGIES"

InnoCaT

Partners

Joint Projects

Project duration:	**3 years** (2010-2012)
Total number of partners:	**60**
Total number of subprojects:	**30 (selected)**
Total project volume:	**approx. 30 Mio Euro**

Innovations-Allianz Green Carbody Technologies

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INNOVATION ALLIANCE "GREEN CARBODY TECHNOLOGIES"

Concept and Structure *"InnoCaT"*

INNOVATION ALLIANCE

A

"Energy and resource efficiency" by business activities and initiatives of the companies

in-house, primarily market-oriented:

- In-house R&D - activities
- Investments in energy efficiency
- New products
- "Sustainability – measures"

B

Precompetitive joint project research

InnoCaT® 1 to 5

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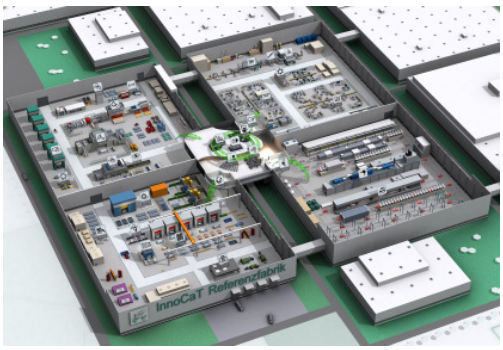
Innovation Alliance "Green Carbody Technologies"
Fields of Research 2010 - 2012

InnoCaT 1 Planning	Systems of **energy information** and **data** management
	Planning **methods** and planning **tools**
	Operative resource management
InnoCaT 2 Press Plant	Resource-efficient **forming processes**
	Energy-efficient **systems engineering**
InnoCaT 3 Tool Making	Energy balance in the **tool life cycle**
	Tool concept for **optimized use of resources**
	Energy-efficient **production** and **repair** in tool making
InnoCaT 4 Car Body Engineering	Evaluation and design of **processes for car body construction**
	Innovative **electrical components** and control technology
	Strategies for **lightweight construction**
InnoCaT 5 Painting	Optimization of the process steps of **spray painting** and **drying**
	Modularization of car body construction



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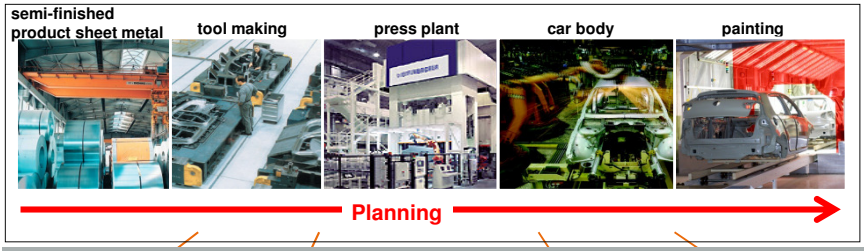
Innovation Alliance “Green Carbody Technologies“

Research Approach

- Research for **car body production,** oriented towards technology and plants
- Integrated approach for early **planning** and permanent **control**



Energy expenditure for **resources**	Energy requirements of **technologies**	Energy consumption of **production equipment**	Energy requirements for **infrastructure**

Research Focus

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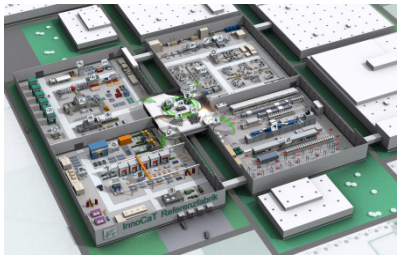
INNOVATION ALLIANCE “GREEN CARBODY TECHNOLOGIES“

The InnoCaT Reference Factory

Concept and Effect



Data and parameters (a selection)

Denomination	Amount	Remark or unit
output	250,000	cars per year
shifts	690	shifts per year
weight of car body, including add-on parts	344	kg
number of sheet parts (outer shell per model)	12	manufactured at OEM
length of the laser-welded seams	21	m
surface of the car body (cataphoretic painting)	90	m^2
surface of the car body (top coat)	24	m^2
energy use – manufacturing of sheet steel (zinc-coated)	9.54	MWh per ton

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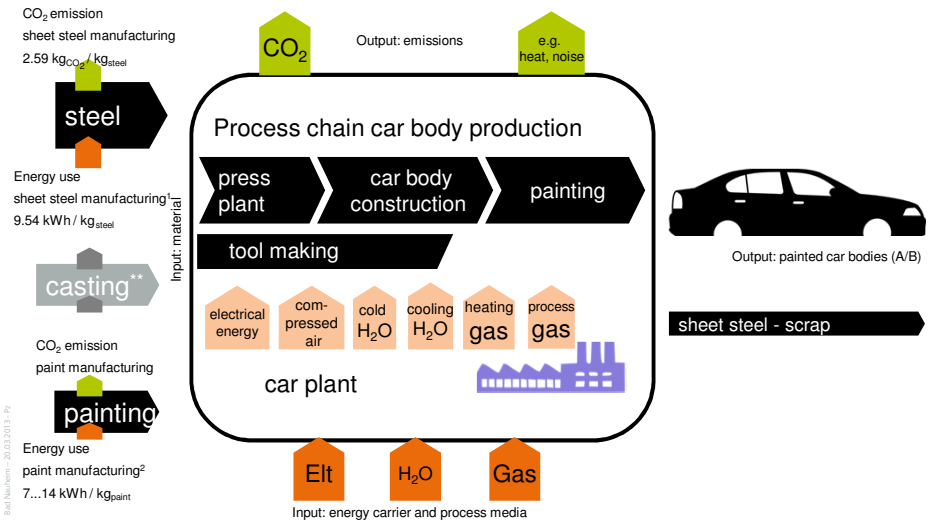
The InnoCaT Reference Factory - *Concept and Effect*

Energy and material flow in the processes of car body production



[1] Source: Federal Environmental Agency, data base PROBAS, 2012
[2] Source: InnoCaT5, 2012

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The InnoCaT Reference Factory - *Concept and Effect*

Evaluation of the InnoCaT effects by using two calculation approaches

"factory" level

total energy expenditure

Real energy consumption (electrical, gas, compressed air) of the assembly sections press plant, tool making, car body construction and painting

+ proportionate demand of central infrastructures

+ cumulated energy expenditure for material (steel, paint)

→ scaled to reference factory (production volume)

→ divided to assembly sections and individual stations

Potential in the subproject evaluation → *InnoCaT*-effect for the total reference factory

direct energy requirements

"product" car body

Specific energy requirements (electrical energy, gas, compressed air) for typical product-oriented operations in above-mentioned assembly sections
+ cumulated energy expenditure for material (steel, paint)

→ projected to size per car body Klasse A / B

→ projected to reference factory (production volume)

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The InnoCaT Reference Factory: Basis → Benchmark

Total Requirements of Energy and Material

	Reference Factory (without assembly)	Reference Car Body (250,000 pieces/a)
Electrical energy "from the outlet" (process energy in the producing units)	131,406 MWh/a	513 kWh
Totel requirements of electrical energy (including other volumes – among others, infrastructure)	205,575 MWh/a	823 kWh
including requirements of compressed air (0.13 kWh/m³ i.N.)	13,016 MWh/a	52 kWh
Natural gas (in the producing units)	132,069 MWh/a	508 kWh
Total requirements of natural gas (including other volumes – among others, infrastructure and heating)	194,536 MWh/a	760 kWh
Energy and material – as regards comparability converted to **primary energy expenditure**		
Cumulated Energy Expenditure (CEE) electrical energy (primary expenditure) (in the producing units)	388,961 MWh/a	1.518 kWh
CEE natural gas (primary energy) (in the producing units)	147,917 MWh/a	568 kWh
Total CEE steel (concentrated on press plant) (k=60%)	1,414,608 MWh/a	5.588 kWh
Total CEE paint	149,545 MWh/a	600 kWh
Total CEE casting (only tool making)	46,891 MWh/a	21 kWh
Total sum = CEE electricity + gas + steel + paint + casting (primary energy expenditure)	2,147,922 MWh/a	8.293 kWh

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   - Analysis of results

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»Planning of Low-Energy Production«
frame-project *InnoCaT 1*

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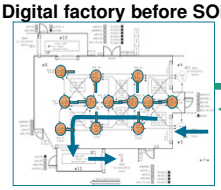
Today:
- “Energy“ underrepresented as criterion of planning and control
- Evaluation of energy efficiency is subjective and inhomogeneous

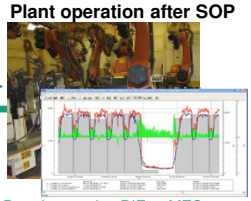
Research focus: **“energy data sensitivity“**

1. **Production information systems** → **Energy-related efficiency indicators**
2. **Planning before SOP (“digital factory“)** → **Energy parameters comprehensive of several units**
3. **Production control (after SOP)** → **Comprehensive resource control**

Digital factory before SOP | **Making energy measurable and assessable** | **Plant operation after SOP**



Recording and management of the models (PPR), energy data and measured values



Planning tools with a function of energy prognosis

Reference numbers and IT basis components (data-/models, interfaces, service)

Data integration DiFa - MES for energy-sensitive control

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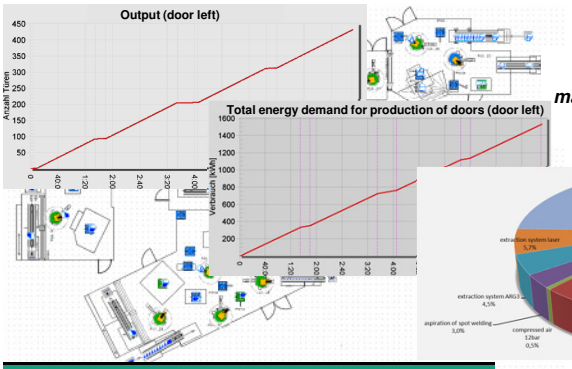
TP 1.1.1

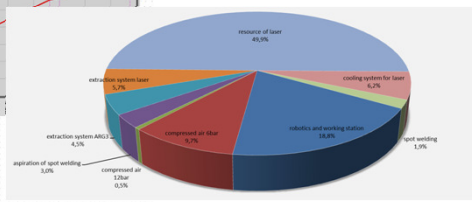
Basis Analyses, Models and Concepts for Representation, Integration and Evaluation of Energy Data in Production Information Systems



Realistic simulation of

material flow and energy consumption

with PLANT SIMULATION™



Reduction as a result of the project

Reduction of electrical energy in the reference factory by specific turning off of the plants	4,837 MWh per year

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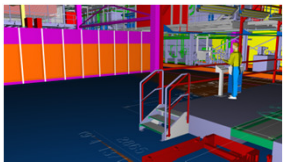
TP 1.2.1

Concepts of the Digital Factory for the Optimization of the Energy Requirements Including Several Units

Digital Planning Tools

- Press plant planning
- Process simulation car body construction
- Robot energy efficiency



Reduction as a result of the project

Reduction of electrical energy in the reference factory by energy efficient robotics	2,565 MWh per year
Material reduction in the reference factory by improved blank exploitation	6,143 t per year

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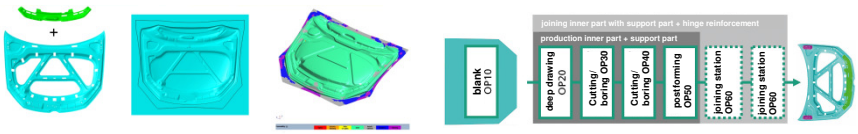
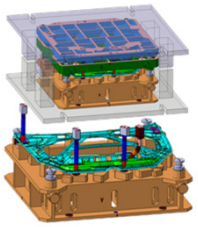
TP 2.1.3 *Reduction of Required Resources by Process Combination*

New Technological Approaches by Process Integration of Forming and Joining Operations!



Verification of the Feasibility of Combined Forming and Joining in Practice in a Press Line, Using the Example of an Engine Hood!

Reduction as a result of the project	
Reduction of primary energy in the reference factory	11,928 MWh per year
Mass reduction (sheet steel) in the reference factory	1,250 t per year

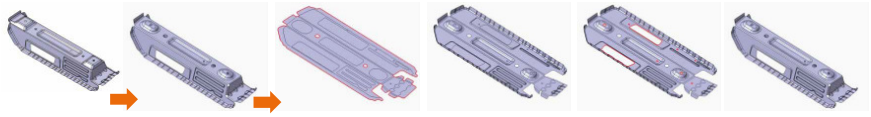


Design of a test tool: joining of an engine hood

TOWER AUTOMOTIVE · SWZ SIEBENWURST WERKZEUGBAU · KUKA · Fraunhofer IWU

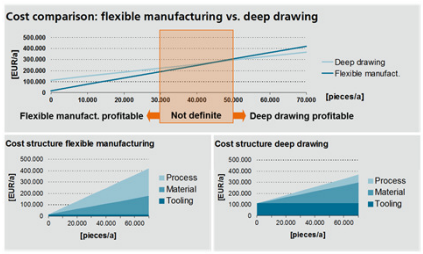
TP 2.1.5 *Novel Production Method for Structural Sheet Components in Small and Medium Series of up to 50,000 Pieces per Year*

Development of a Production Method for Small ans Medium Number of Pieces with Simultaneous Increase of Flexible Production Steps.



initial part · remodeling for flexible production · AFO 10 first trimming · AFO 20 deep drawing without flange · AFO 30 second trimming · AFO 40 folding

Remodeling of the demonstrators seat cross beam: one single forming step with subsequent flexible production on sheet processing machines allows for economic production at decreasing number of pieces.



TOWER AUTOMOTIVE · TRUMPF · Fraunhofer IWU

TP 4.1.2 *Automatic Adjustment of Equipment for Car Body Construction*

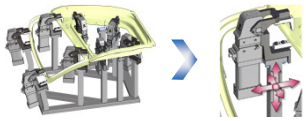
50 % Reduction of the Plant Run Time by More Efficient Adjustment of the Equipment for Car Body Construction, as well as 50 % Reduction of Reworking by Faster Reaction to Component Deviation without Interrupting the Production.

Motivation

- long, cost-intensive adjustment stages of equipment for car body construction
- manual exchange of shims

Approach

- Mechanization of the manual adjustment process
- Relocation of the drive for reducing the installation space
- efficient control of several modules with one drive



Example of a rigid fixture design

Clamping element with mechanized axes of adjustment

Reduction as a result of the project	
Reduction of electrical energy in the reference factory	668 MWh per year

testing stand

TP 4.2.1 *Energy-Efficient Air Conditioning of Control Cabinets*

Goal of passive measures:

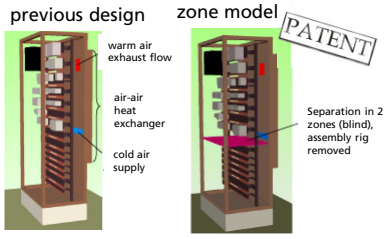
- Optimization of control cabinet designs for energy-efficient air conditioning
- Design and construction of prototypes of a control cabinet wiring system suitable for these conditions

Goal of active measures:

- Definition of a development guideline
- Generation of efficient air handling units
- Design and construction of prototypes of optimal cold air generators, e.g. hybrid heat exchanger and RPM-regulated compressor cooling device

Results:

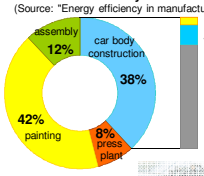
- Today at least 35% savings by new cold air generators
- High potential existing by using new solutions, such as air-air / air-water hybrid heat exchangers
- Average of 23% savings by new wiring system with flow-optimized routing of cold air flow in order to avoid heat pockets and maximum use of the cold air flows



Innovation Alliance Green Carbody Technologies

Configurable Energy Management System – Project Example

Consumption of electrical energy in the automotive industry
(Source: "Energy efficiency in manufacturing", FhG)



lighting (5%)
ventilation (13%)
technology (82%)

Paint shop and lacquering

Body shop technology and systems

Forming technology and press shop

Tool making and machine tools

Material and Metal sheets

Joint Project 4 - Contents

4.1 Evaluation and design of processes for car body construction

4.2 Innovative electrical components and control technology

4.3 Strategies of lightweight construction

4.2.2
Configurable Energy Management System

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TP 4.2.2 *Configurable Modular Energy Management System*

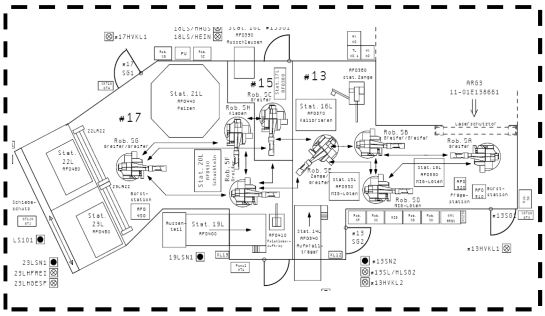
If you can't measure it – you can't manage it!

punching

glueing

laser welding

spot-welding



robot-handling

brushing

MIG soldering

Process Functions
Line for car body construction - Golf VI back door

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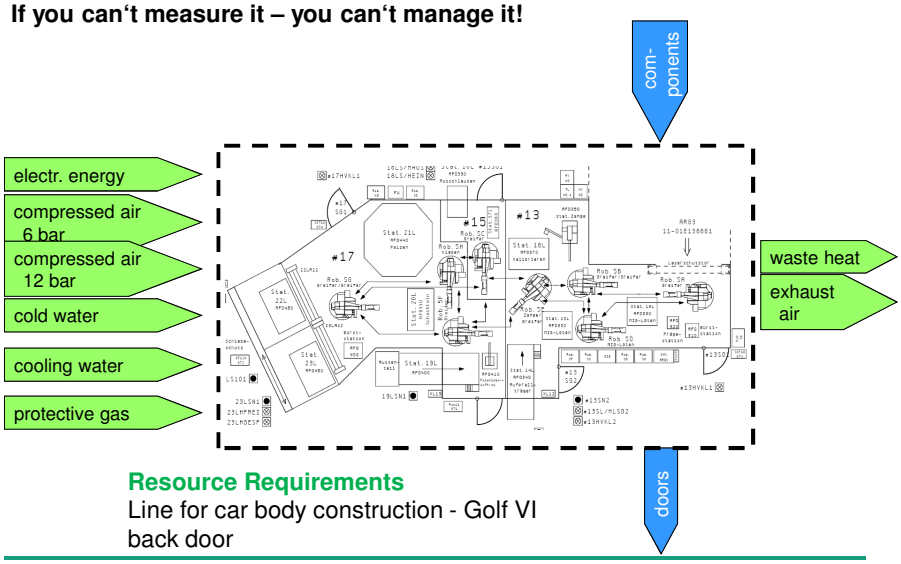
TP 4.2.2 *Configurable Modular Energy Management System*

If you can‘t measure it – you can‘t manage it!



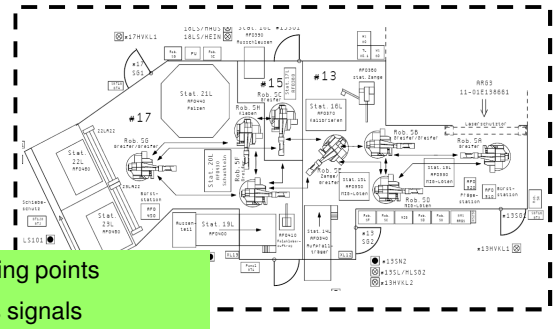
Resource Requirements
Line for car body construction - Golf VI
back door

TP 4.2.2 *Configurable Modular Energy Management System*

If you can‘t measure it – you can‘t manage it!

Reference Values of the Plant
Line for car body construction - Golf VI
back door

1,200 doors per day



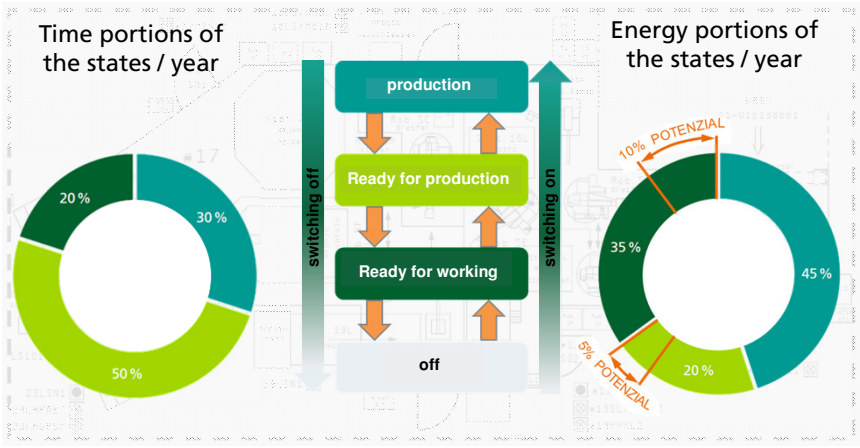
434	measuring points
1007	process signals
10 ms	measuring/archiving rate

25 doors are in the unit at same time

TP 4.2.2 *Configurable Modular Energy Management System*

If you can‘t measure it – you can‘t manage it!

Results



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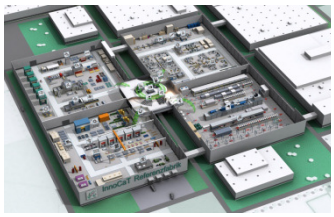
The InnoCaT Reference Factory: Basis → Benchmark

Concept Approach and Data Sources



InnoCaT – **reference factory** ?

Reference – **press plant**

Reference – **car body construction**

Reference – **painting**

Reference – assembly

- Reference values of 3 European automotive plants
- Classification of data from previous analyses (among others, plant Mosel VW Saxony)
- PROBASS data base (BUM) CEE values
- InnoCaT - analyses

Reference – **tool making**

- Analyses in tool making
- Process data in full tool making
- Tool making forum Aachen

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The InnoCaT Results – Implementation of the Solutions in the "Time Line"

Short-term	The implementation into practice has already taken place or nothing is opposed to prompt implementation.	5 subprojects
Medium-term 2 – 3 years	Certain R&D is required for implementation into practice, or the benefit of the solution will only be possible by modifying the process.	19 subprojects
Long-term 3 – 5 years	Considerable "expenditure" still required. Further research needs to be conducted before implentation into practice. Modification of machines and, if necessary, new factory designs are required.	5 subprojects

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INNOVATION ALLIANCE “GREEN CARBODY TECHNOLOGIES“

InnoCaT – a first conclusion

1. The quantified and scalable results are of special value in the *InnoCaT joint research*. So far the sometimes only “selective“ research approach of the subprojects yields further potential.
2. The concept of the innovation alliance has sustainably focused on the compulsion to take action and on the plans of the industrial partners to tackle questions of energy and resource efficiency by innovations in their technologies and systems and to lead the way to market-oriented solutions.
3. The detailed evaluation of the solutions offered by *InnoCaT* shows options of how to develop future points of focus for approaches of research and innovation in production technology for car body construction.

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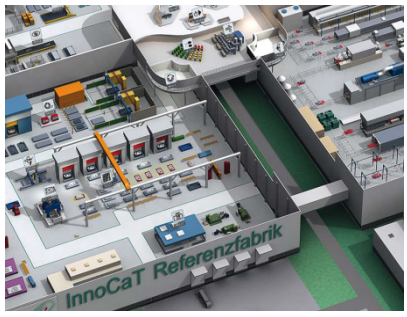
Thank you for your attention!



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