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EVS 27

UNDERSTANDING THE AUTOMOTIVE INDUSTRY German OEM behaviour during the last 20 years and its implications

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Electric Vehicle Symposium 2013 - EVS27
Barcelona 17th - 20th Nov 2013

eit Knowledge & Innovation Community Climate-KIC

Grantham Institute for Climate Change

Imperial College London

Christoph Mazur

- *Developing Sustainable Technology Diffusion Pathways for Alternative Mobility Technologies*

- Background
  - Grantham Institute for Climate Change
  - Climate-KIC (Knowledge and Innovation Community – EU)

  - Energy Adviser (*Parliamentary Office for Science and Technology*)
  - Manufacturing Engineer (*Daimler Buses North America*)
  - Mechanical Engineering & Business Administration (*RWTH Aachen*)
  - Industrial Design and Innovation (*Ecole Centrale Paris*)

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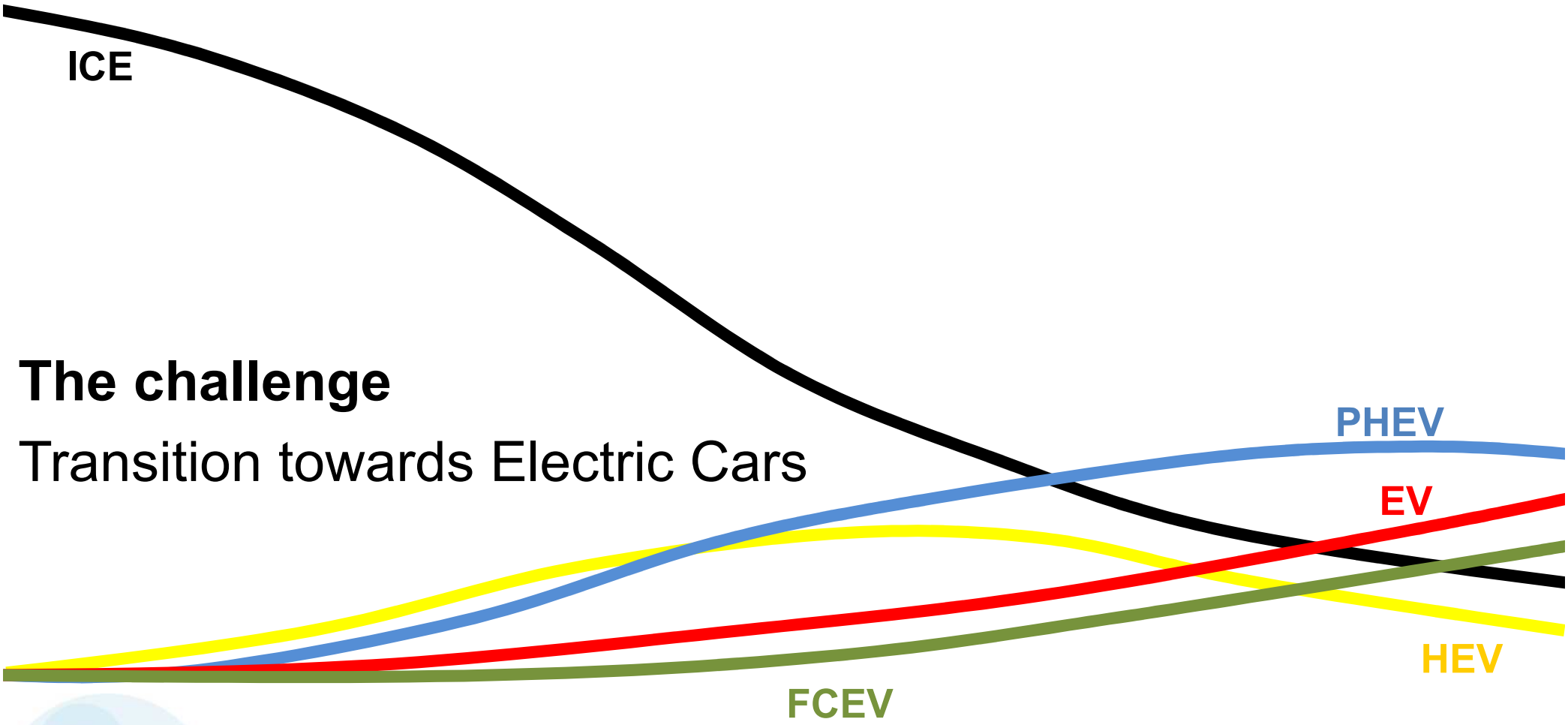

The challenge

Transition towards Electric Cars

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Changes in propulsion technology

Photos: Imalipusrams, S 400 HYBRID, Mario Roberto Duran Ortiz, Avda, Steve Jurvetson (all Wikipedia Commons users) , *stevelyon (Flickr)*

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Changes in manufacturing

Photos: Scania Group, *Steve Jurvetson (flickr)*

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For the Automotive Industry

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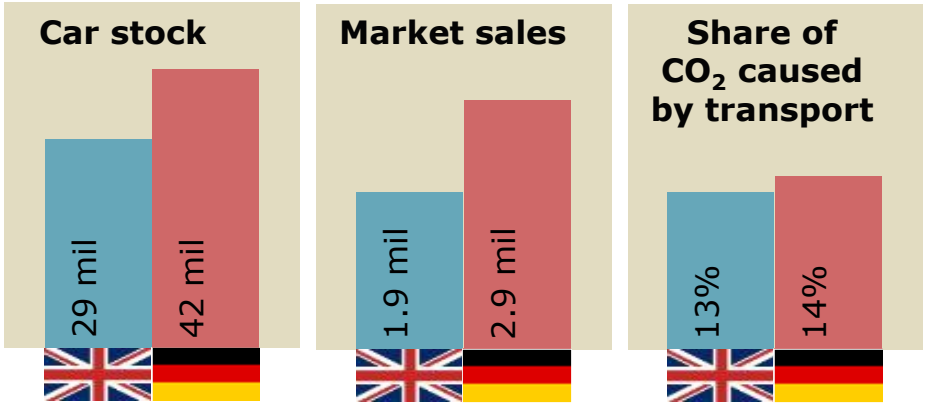
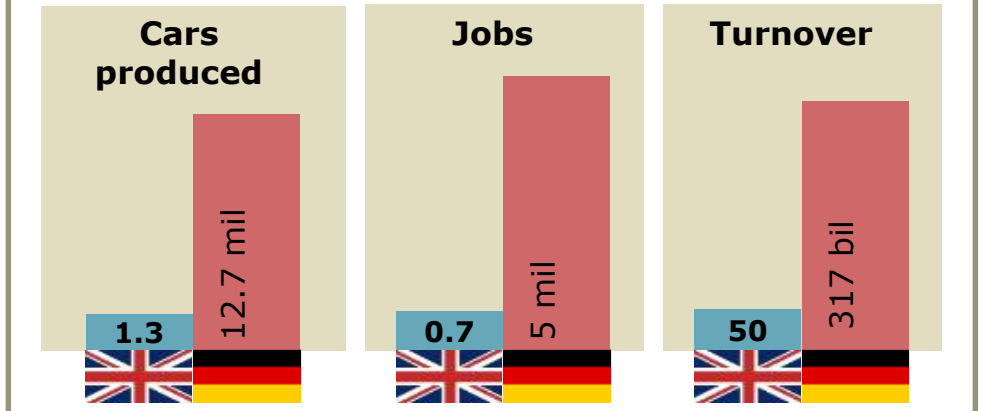
Role of the industry for the economy

Market



Automotive Industry



Industrial Landscape (OEMs)

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Questions?

- *Develop and to achieve Sustainable Technology Diffusion Paths for Alternative Mobility Technologies.*
- *Are the current policies adequate to reach sustainability goals?*
- *Is it possible to predict the consequences of governmental policies and industrial strategies on the transition outcomes for the industry?*

Need to understand automotive industry

The study

Understanding the automotive industry

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Motivation for study

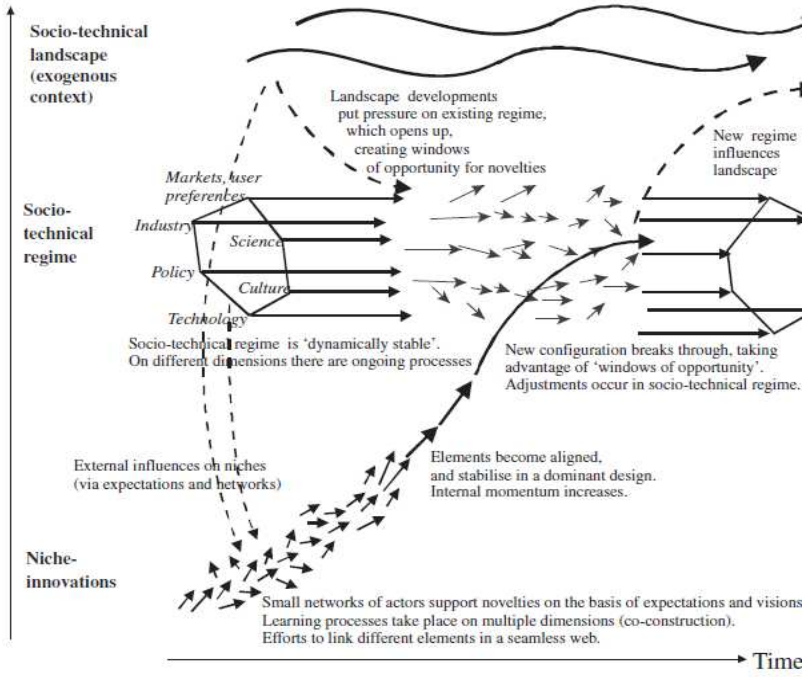
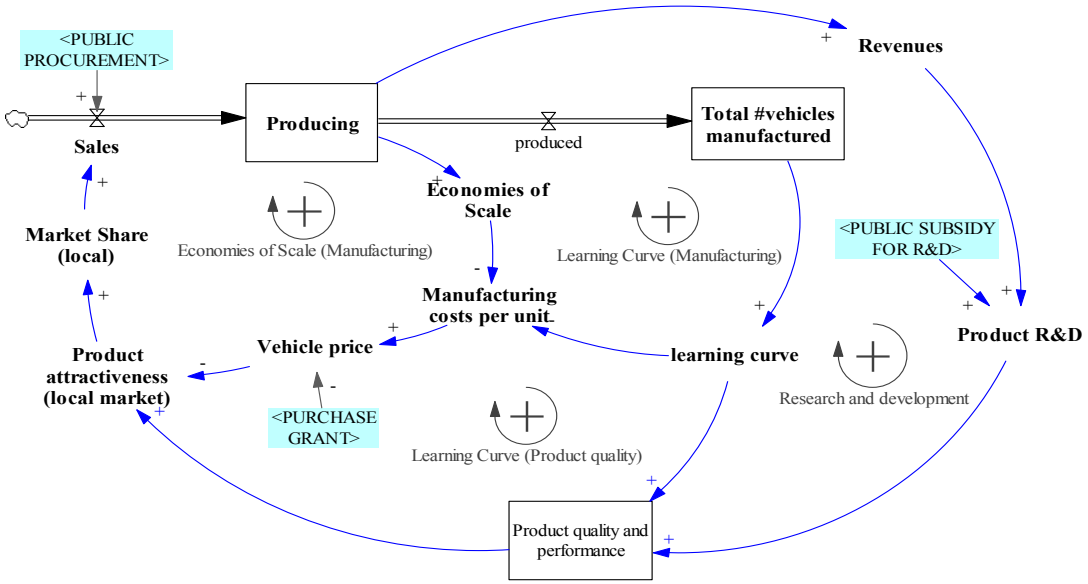


Fig. 2. Multi-level perspective on transitions (adapted from Geels, 2002, p. 1263).



(Geels, 2002)

Obtaining parameters for model

- Technology choice, Research and Development Production, Manufacturing, etc.
- Behavioural patterns
- Triggers
- Time scales
- Typical responds

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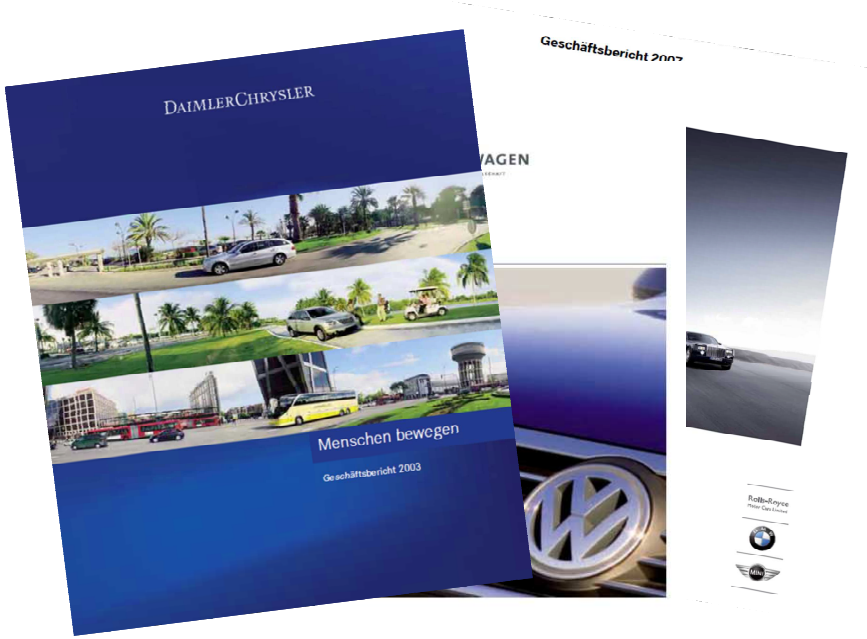
Study of BMW, Daimler and VW since 1990

Scientific journals and press



Annual reports

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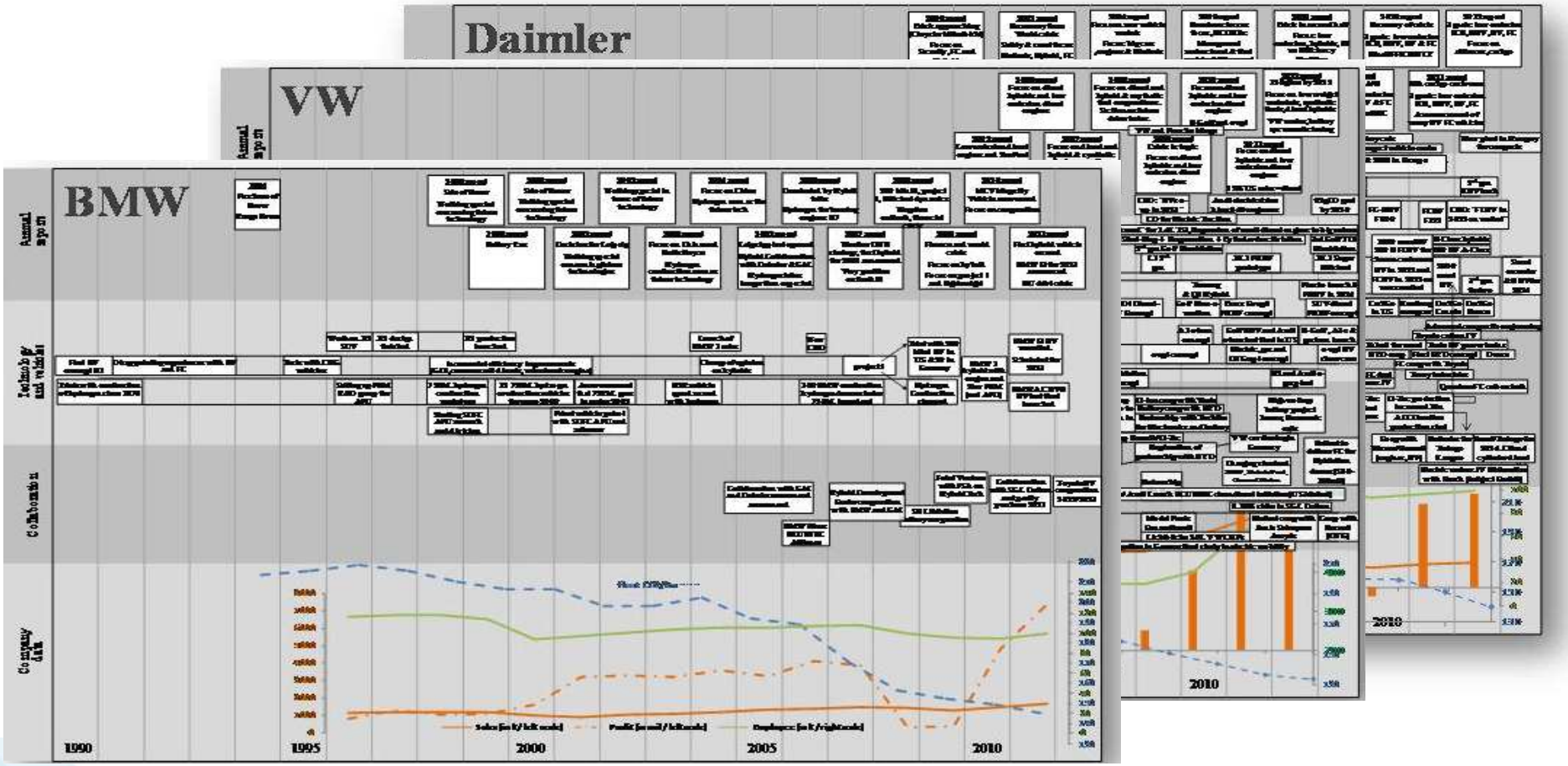
Timelines



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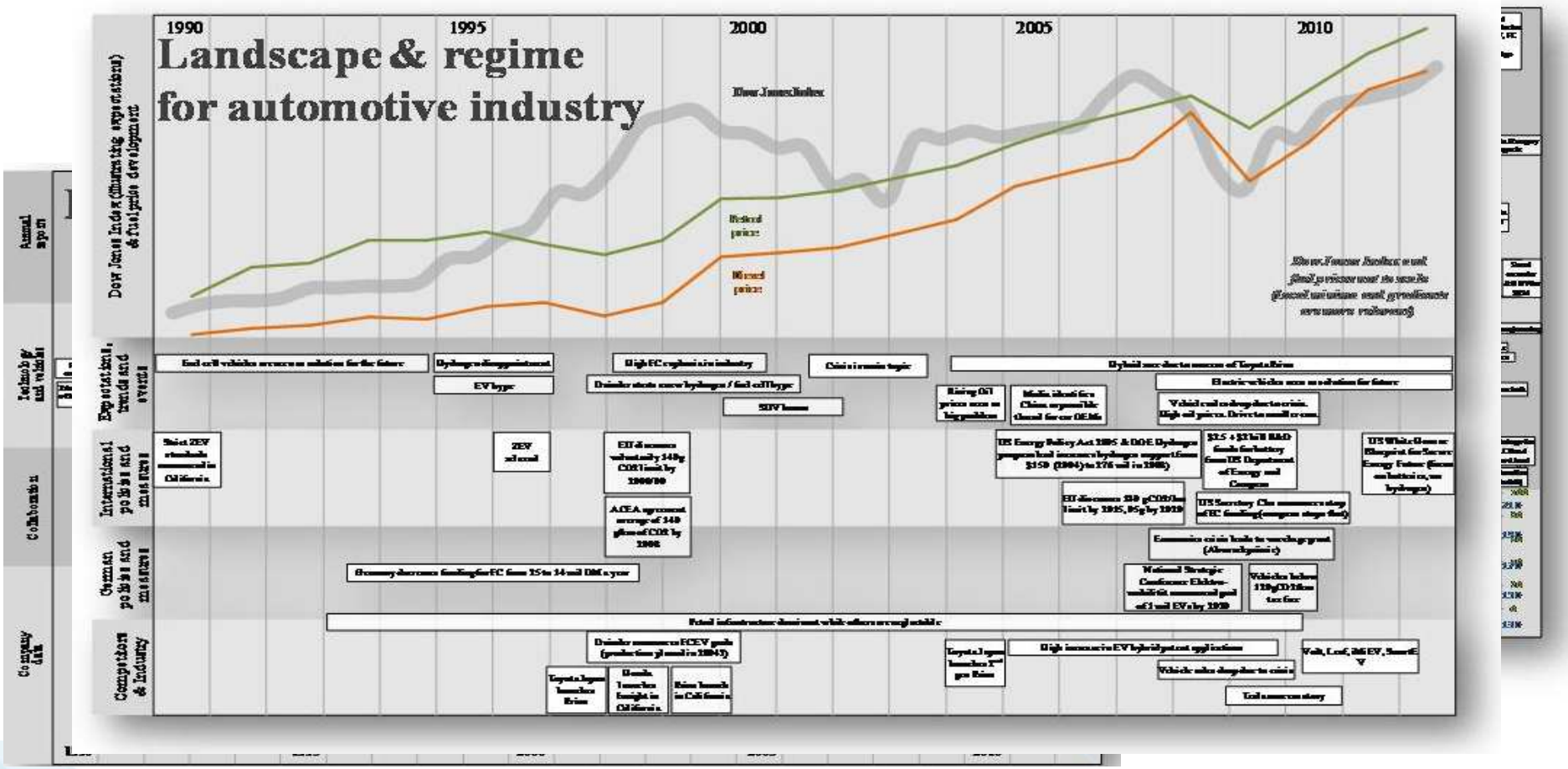
Timelines



The results

BMW, Daimler and VW since 1990

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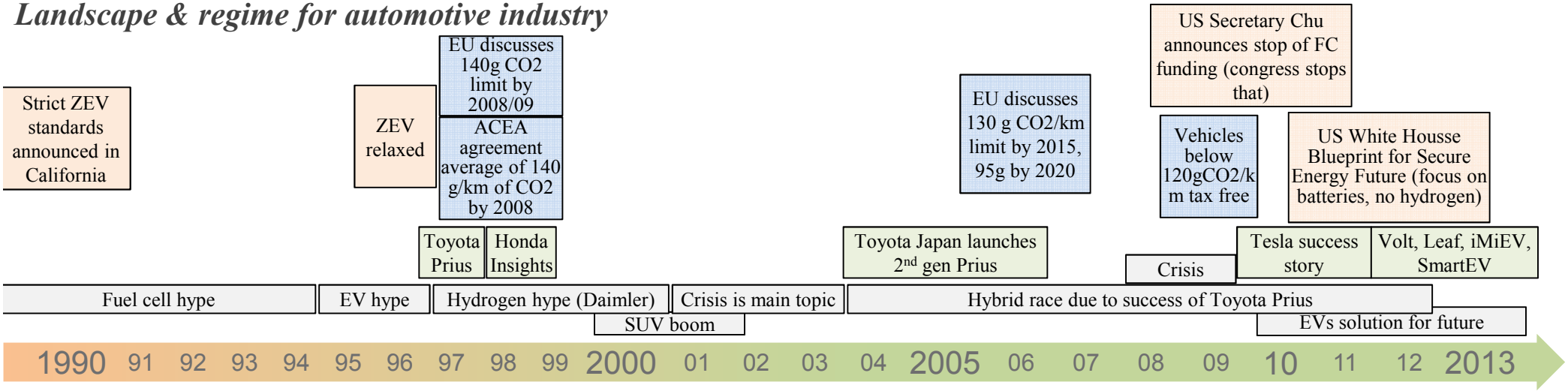
Landscape (the regime)

Germany/EU
USA
Competitors
Mood

Landscape & regime for automotive industry



Internal | R&D and trials | Product/concept | Collaboration

Knowledge & Innovation Community Climate-KIC

Grantham Institute for Climate Change

Imperial College London

Story of BMW

Germany/EU
USA
Competitors
Mood

Landscape & regime for automotive industry

Strict ZEV standards announced in California

ZEV relaxed

EU discusses 140g CO2 limit by 2008/09

ACEA agreement average of 140 g/km of CO2 by 2008

Toyota Prius

Honda Insights

EU discusses 130 g CO2/km limit by 2015, 95g by 2020

US Secretary Chu announces stop of FC funding (congress stops that)

Vehicles below 120gCO2/km tax free

US White Housse Blueprint for Secure Energy Future (focus on batteries, no hydrogen)

Toyota Japan launches 2nd gen Prius

Crisis

Tesla success story

Volt, Leaf, iMiEV, SmartEV

Fuel cell hype | EV hype | Hydrogen hype (Daimler) | Crisis is main topic | Hybrid race due to success of Toyota Prius

SUV boom

EVs solution for future

1990 91 92 93 94 95 96 97 98 99 2000 01 02 03 04 2005 06 07 08 09 10 11 12 2013

BMW

Work on X5 SUV

X5 design finished

X5 production launched

Launch of BMW I sales

New CEO

Trial with 500 Mini EV in US & 50 in Germany

BMW 1 hybrid with engine and 5kw PEM (not APU)

BMW i3 EV unveiled. Scheduled for 2013

BMW i3 EV launched

BMW ACTIVE EV test fleet launched

First EV concept E1

Disappointing experiences with EV and FC

Tests with LNG vehicles

efficiency improvements (GDI, common rail diesels, valvetronic engine)

Change of opinion on hybrids

project i

Trials with combustion of hydrogen since 1979

Setting up PEM R&D group for APU

750hL hydrogen combustion prototype

15 750hL hydrogen combustion vehicles for expo 2000

Announcement that 750hL goes in series 2002

H2R vehicle speed record with hydrogen

100 BMW combustion hydrogen demonstrator 750hL leased out

Hydrogen Combustion stopped

Starting SOFC APU research and division

Petrol vehicle petrol with SOFC APU and reformer

BMW Nixes BLUETEC Alliance

SB LiMotive battery cooperation

Collab with GM and Daimler announced

Hybrid Develop Center coop with GM

Joint Venture with PSA on Hybrid Tech

Collaboration with SGL Carbon and partly purchase 2011

Toyota EV cooperation 2012/2013

Internal | R&D and trials | Product/concept | Collaboration

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Story of Daimler

Germany/EU
USA
Competitors
Mood

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1990 91 92 93 94 95 96 97 98 99 2000 01 02 03 04 2005 06 07 08 09 10 11 12 2013

Daimler

New CEO
Daimler AG
Sust.division restructuration
CDI technology
Bluetec-Diesel in USA & 2008 in Europe
Mild-hybrid and start-stop
Stop of H2 ICE
Dornier Fuel Cell team switched from space work on fuel cell vehicle
First FCEV Necar I
FCEV Necar II
FC Necar III methanol reformer
C Necar IV, A, andwich floor
CEO: "100k FCEVs in 2004"
FCEV Necar V
Diesel HEV F500
FCEV F 600 HY
FCEVs expected in 2012-15
B, FC, PHEV concepts in Detroit
FC-HEV F 800
FCE V F125
CEO: "FCEV in 2015 on market"
20 EVs trials
SmartEV with Zytek
A class EV 2010
SLS EV
1000 smartEV 200 B FCEV
E-Class hybrids
500 EV A-Class
Smart announced
Smart sales below expectations
Smart forfour presente
Low sales 8600 jobs lost
Smart forfour stopped
100 Smart EVs
SmartEV trial in Berlin
S 400 Hybrid
2000 smart EV
3rd gen fortwo
Smart escooter & B EV for 2014
Swatch Micro Compact JV
Car2Go pilot GER
in US
Hamburg
CA
FR
Ballard FCs for bus
Stake in Ballard
JV Ford Ballard
Cal FC Partnership Ford, Ballard, BP, Shell
Ballards sells FCEV division
Ballard FC deal
Ford leaves JV
Diesel HEV collaboration GM & BMW
Battery (Li-Tec) & BMS (ACCUmotive) JV with Evonik. Mass market in 2012?
Li-Tec plant opens
Li-Tec production increased 10x
ACCUmotive production start
10% Tesla,. 1000 batteries for smart

Internal | R&D and trials | Product/concept | Collaboration

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Story of VW

Germany/EU | USA | Competitors | Mood

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EVs solution for future

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New CEO (with engine background)

Strategie 2018

CEO: "EVs e-up in 2013"

Audi electric drive hires 840 engineers

95gCO goal by 2020

EVs only perceived as niche (focus on combustion)

Focus on highly efficient combustion; Natural gas vehicles; Second-generation biofuels (e.g., BTL and cellulosic ethanol);

Lupo 3L

Introduction of gas and petrol bi fuel vehicles

AudiA 2 3L

VW 1-liter car

Pilot plant for Sun diesel

1-liter car, A2L3 cancelled & Lupo

Diesel Polo Bluemotion

Golf Blue Motion

1-liter car revived

7 years "Best New Engine Award"1.4L TSI. More small engines to sedans

TDI + Start-Stop + Reg. + Cyl. deactiviation

Golf BlueMotion

L1 2nd gen

XL1 PHEV prototype

Golf TDI BlueMotion

XL1 Super Efficient

Chico PHEV at IAA

Full hybrid SUVs (Cayenne based)

A3 HEV concept

Golf TDI Diesel- HEV Concept

Touareg & Q5 Hybrid

Golf Blue-e-motion

Cross Coupé PHEV concept

Plan to launch 6 PHEV in 2014

SUV diesel PHEVconcept

A1 e-tron

Golf BEV Audi e-tron

E-Golf , A3 e & gas tron launch

up! concept

e-up! concept

Electric, gas and CNG up!

e-up! EV show case

VW

Capri Project 96-2000, Golf HEV (20 kW FC) concept

FC concept (PSI in 2001)

Touran Hy Motion FC

High temp PEM

FCEV concept

H2 and e-gas plant

Battery coop with Sanyo (2006), Varta and Toshiba (2009), Panasocnic (2012)

DaimlerChrysler and VW/Audi Launch BLUETEC clean diesel initiative (US Market)

Alliance for Synthetic Fuels Europe" (ASFE)

Model Fuels Consortium

Lichtblicke 2.0L VW CHPs

Biofuel Cooperation

Coop with Rosneft (CNG)

Internal | R&D and trials | Product/concept | Collaboration

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Comparison

Germany/EU
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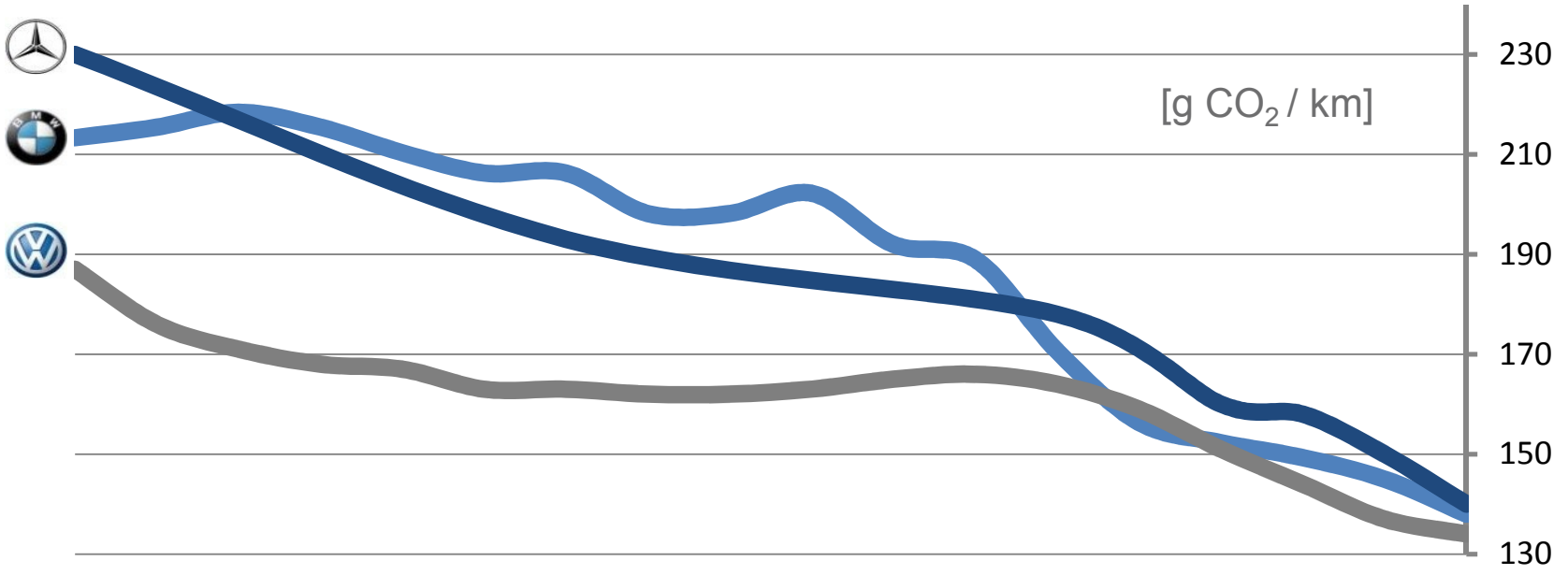

The conclusions

Technology choices: behavioural patterns of German car manufacturers

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Common patterns with regard to pressures

- No changes without significant external pressures
  - Emission targets in Europe
  - ZEV in California
  - Perception of rising fuel prices
- Regulations and consumer pressure are main drivers for technology change while national /global economic indicators not
- Research subsidies not sufficient

R&D bound to long term goals and decisions

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Common patterns with regard to solutions

- New solutions are created through combinations of available internal solutions
- However, disruptive only triggered by disruptive (internal) events
  - New CEOs
  - Competitor's 'success' (Toyota Prius, Daimler FCEV)
  - Consumer pressure
- Knowledge on disruptive or less familiar technologies is obtained from third parties

Future work: Quantification of findings

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Thanks for attention

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