


The Greening of the Automotive Industry



Edited by Giuseppe Calabrese

GERPISA



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CNR-Ceris, Moncalieri, Italy

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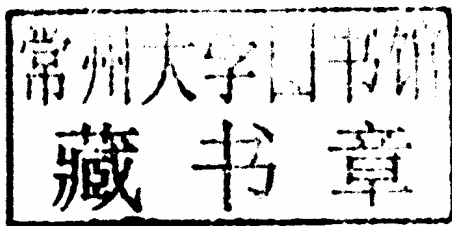
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(International Network of the Automobile)

Groupe d'Étude et de Recherche Permanent sur l'Industrie et les Salariés de l'Automobile

(Permanent Group for the Study of the Automobile Industry and its Employees)

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'The awe, the marvel of this reality which imposes itself upon me, of this presence which reaches me, is at the origin of the awakening of human consciousness.'

Luigi Giussani, *The Religious Sense*

List of Abbreviations

ABS	anti-lock braking system
AC	alternating current
ACEA	Association des Constructeurs Européens d'Automobiles (European Automobile Manufacturers Association)
ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie (French Environment and Energy Management Agency)
AFDC	Alternative Fuels and Advanced Vehicles Data Center (USA)
Ah	ampere hour
AHP	Analytic Hierarchy Process
ANFAC	Asociación Española de Fabricantes de Automóviles y Camiones (Spanish association of Manufacturers of Automobiles and Trucks)
ANFAVEA	Associação Nacional dos Fabricantes de Veículos Automotores (National Association of Motor Vehicle Manufacturers) (Brazil)
ANP	Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (National Agency for Petroleum, Natural Gas and Biofuels) (Brazil)
ASEAN	Association of Southeast Asian Nations
AV	alternative vehicle
BDVE	Business Development Véhicule Electrique (France)
BEV	battery electric vehicle
BPT	business package team (Volvo)
BRIC	Brazil, Russia, India and China group of countries
CBG	compressed biogas
CCFA	Comité des Constructeurs Français d'Automobiles
CENARGEN	Genetic Resources and Biotechnology Centre for Plants (Brazil)
CEO	chief executive officer
CEPREMAP	Centre for Economic Research and Its Applications (France)
CNG	compressed natural gas
CNGV	CNG vehicles
CNPA	Conseil National de Professions de l'Automobile
CNR/CERIS	Consiglio Nazionale de Ricerche

CNRS	National Centre for Scientific Research (Paris, France)
CO	carbon monoxide
CO ₂	carbon dioxide
CTA	Comando-Geral de Tecnologia Aeroespacial (General Command for Aerospace Technology) (Brazil)
CTC	Centro de Tecnologia Canavieira (Sugarcane Technology Centre) (Brazil)
DC	direct current
DI	direct injection (system in diesel engines)
DOE	US Department of Energy
DSO	distribution system operator
EASYBAT	Easy and Safe Battery Switch in an EV
EC	European Community
ECMD	European Centre for Mobility Documentation (The Netherlands)
EDF	Électricité de France
EES	electric energy storage (or system)
EFTA	European Free Trade Association
EFTE	European Federation for Transport and Environment
EHES	School of Higher Studies in the Social Sciences (Paris, France)
EIA	US Energy Information Administration
ELV	End of Life Vehicle Directive
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Enterprise for Agricultural Research)
EPA	Environment Protection Agency (USA)
EPO	European Patent Office
ESC	electronic stability control
EU	European Union
EU FP7	The Seventh Framework Programme of the European Union for the funding of research and technological development in Europe
Euro NCAP	European New Car Assessment Programme
EV	electric vehicle
FAW	FAW Group Corporation (Chinese car manufacturing group)
FCC	Federal Communications Commission
FCEV	fuel cell electric vehicle
FCV	fuel cell vehicle
FDI	foreign direct investment
FE	front end

FFE	fuzzy front end
FFV	flexible fuel vehicle
FIEV	La Fédération des Industries des Equipements pour Véhicules (Federation of Industries of the Equipment for Vehicles)
FUPET	Future Power Electronics Technology
GE	General Electric
GEA	Gustaf Ericssons Automobilfabrik (former automobile manufacturer)???
GEIA	Automobile Industry Executive Group (Brazil)
GEM	Global Electric Motorcars
GERPISA	Groupe d'étude et de Recherche Permanent sur l'Industrie et les Salariés de l'Automobile
GERRI	Grenelle de l'Environnement à la Réunion – Réussir l'Innovation [Green Energy Revolution – Réunion Island]
Gg	gigagram
GGE	Gasoline gallon equivalent
GHG	greenhouse gas
GM	General Motors
GPS	Global Positioning System
GS Yuasa	GS Yuasa Corporation
GSM	Groupe Spécial Mobile
HC	volatile hydrocarbons
HDV	heavy duty vehicle
HEV	hybrid electric vehicle
HMI	human machine interface
HPCU	hybrid power management control unit
HV	high voltage
i-MiEV	Mitsubishi innovative Electric Vehicle
ICE	internal combustion engine
ICT	information and communication technology
IEA	International Energy Agency
INRIA	Institut National de Recherche en Informatique et en Automatique (National Institute of Automatic Control Systems and Information Technology [France])
IPI	Imposto sobre Produtos Industrializados (Brazil – federal excise tax on manufactured goods)
IPT	Instituto de Pesquisas Tecnológicas (Technological Research Institute, São Paulo state, Brazil)
KWh	kilowatt hour

LCO	lithium cobalt oxide (battery)
LED	light-emitting diode
LFP	lithium iron phosphate (battery)
LG	LG Corporation
Li-Ion	lithium-ion (battery)
LMO	lithium manganese oxide (battery)
LMP	lithium-metal-polymer (battery)
LNG	liquid (or liquefied) natural gas
LOLP	loss of load probability
LPG	liquefied petroleum gas
LSEV	low speed electric vehicle
LTO	lithium titanate (battery)
LV	low voltage
MAN	MAN SE (Maschinenfabrik Augsburg-Nürnberg), a Munich-based German engineering and manufacturing company best known for its buses and heavy trucks.
M&As	mergers and acquisitions
MEA	more electric aircraft
MMA	Ministério do Meio Ambiente (Ministry of the Environment, Brazil)
MPa	megapascal
MV	medium voltage
NCA	lithium nickel cobalt aluminium oxide (battery)
NCAP	New Car Assessment Programme
NEC	Nippon Electric Company
NEDC	New European Driving Cycle
NERC	North American Electric Reliability Corporation
NG	natural gas
NiMH	nickel-metal hydride (battery)
NMC	lithium nickel manganese cobalt oxide (battery)
NMHC	non-methane hydrocarbons
N ₂ O	nitrous oxide
NOx	oxides of nitrogen
NPD	new product development
OECD	Organisation for Economic Co-operation and Development
OEM	original equipment manufacturer
OLED	organic light-emitting diode
OPEC	Organization of the Petroleum Exporting Countries
PHEV	plug-in hybrid electric vehicle

PLM	product lifecycle management
PM	particulate matter
PNNL	Pacific Northwest National Laboratory (USA)
QCD	quality–cost–delivery
R&D	research and development
RATP	Régie Autonome des Transports Parisiens (Independent Paris Transport Authority)
RON	research octane number
rpm	revolutions per minute
SAIC	Shanghai Automotive Industry Corporation
SCR	selective catalytic reduction
SFS	software fuel sensor
SHVC	Swedish Hybrid Vehicle Centre
SNCF	Société Nationale des Chemins de Fer Français (French National Railway Company)
SO _x	sulphur/sulfur oxides
SUV	sport utility vehicle
TCO	total cost of ownership
TFM	transverse flux machine
THS	Toyota Hybrid System
TWh	terawatt hour
UAE	United Arab Emirates
UITP	International Association of Public Transport
ULEV	ultra low emission vehicle
UN FCCC	United Nations Framework Convention on Climate Change
UNICA	União da Indústria de Cana-de-Açúcar (Sugar Cane and Ethanol Industry Association) (Brazil)
USPTO	US Patent and Trademark Office
VACAR	Virginia and Carolinas, USA
VTLIB	Véolia urban transport
VU log	Web-based service tells its registered users where to find the nearest available electric car. The common pool of small shared electric cars is part of the car-sharing initiative.
V2G	vehicle to grid
VOC	volatile organic compound
w.a.	weighted average
WTW	well-to-wheel (supply path of gas/oil)
ZEV	zero emissions vehicle

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Foreword

GERPISA, the international network for research on the automobile, developed between 2007 and 2011 its fifth research programme, entitled 'Sustainable Development and the Automobile Industry'. Its aim is to understand the extent to which companies and states have taken into account the exigencies of sustainable development, and how they are doing so. More precisely, the intention is to measure the scale and pace of the changes that increasingly important political and social requirements have placed on the industry. These changes are related to different interlinked dimensions: as often stressed by the literature on sustainable development, public and corporate actors have indeed to develop synergies (but also to make trade-offs) between environmental performance, economic performance and social progress.

This is why, since 2007, GERPISA has linked the analysis of the quest for better vehicle performances in terms of emissions with a more general examination of the other constraints that have a simultaneous effect on the development of corporate strategies and of public policy regulations. The 2008–09 crisis has been a brutal reminder of the importance of these other constraints. Environmental sustainability is certainly important, but the economic sustainability of the products sold by the carmakers and of the processes involved in production is still a problematic dimension of automobile production worldwide. This economic sustainability, as GERPISA has always stressed, is linked both to the microeconomic capability of firms to make a profit as well as to develop coherent strategies within their own macroeconomic environment on the one hand, and in relation to employment conditions of workers, on the other.

This collective work edited by Giuseppe Calabrese is the first book published from GERPISA's 5th international research programme. Its main focus is on the issues related to technological innovations aimed at achieving better environmental performance of automobile products. It approaches these questions from a wide variety of points of view. Such an approach reflects not only the value-added generated by the mobilization of an international network to explore such a complex set of questions, but also the interest to the scientific community working on sustainable development of interacting with a network of researchers who have developed a detailed knowledge of the automobile industry and its history. By combining this expertise about the industry with an analysis of the dynamics implied by the integration of the environmental exigencies, the book provides an insightful measure of the changes that are taking place.

It shows in particular that, beyond their technological relevance, these changes have already acquired a new economic and geopolitical dimension: what is at stake today, beyond the reduction of emissions, is the capacity of this industry to make a 'second revolution'; to find, in the context of the extraordinary growth of production and demand in emerging countries, ways to a renewed sustainability. If these ways are still far from clear in 2012, the contributions gathered in this book allow us to grasp those that are emerging and the automotive worlds to which they might lead.

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Christian Berggren is Professor of Industrial Management at the University of Linköping, Sweden and Director of the KITE research programme, 'Knowledge Integration and Innovation in Transnational Enterprise'. He has written extensively on production systems, and product development and innovation, especially within the automotive, electro-technical and telecommunications industries. Published titles include *The Volvo Experience* (Macmillan, 1992); *The Resilience of Corporate Japan* (Sage, 1997); and *Knowledge Integration and Innovation: Critical Challenges Facing International Technology-Based Firms* (Berggren *et al.*, Oxford University Press, 2011). His current research focuses on the competition for sustainable vehicles in the automotive industry, innovation processes and individual innovators, and the role of regulation in driving innovation.

Ettore Bompard is an Associate Professor of Power Systems at Turin Polytechnic. He is co-ordinating several European and international projects in the field of electricity markets restructuring (generation scheduling, congestion management design, security impacts on the competitive markets, electricity markets simulation). His research interests include power systems security, electrical energy efficiency, smart grids, and electricity market analysis and simulation. He has co-authored more than 100 publications on various topics related to power systems analysis.

Giuseppe Calabrese is a senior researcher at CNR-Ceris (the National Research Council's Institute for Economic Research on Firms and Growth) in Moncalieri, Italy, and teaches as a Visiting Professor of Managerial Economics at the University of Turin. He is co-editor of the *International Journal of Automotive Technology and Management* and a member of the International Steering Committee of GERPISA. His main topics concern

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Marc Dijk is a Research Fellow at Maastricht University, The Netherlands. He has developed a model for analysing paths of innovation in car mobility. His micro-macro framework with co-evolution of demand and supply emphasizes feedback effects and stakeholder perspectives, combining evolutionary economics with the sociology of technology. He has determined the framework for the case of electric and hybrid-electric engines on the automobile market after 1990. He believes that the main merit of a co-evolutionary, micro-macro approach is the integrated analysis of consumers and firms, and competition between technologies.

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Takahiro Fujimoto is currently Professor in the Graduate School of Economics at the University of Tokyo, Japan, a position he has held since 1998. He has also served as Executive Director of the Manufacturing Management Research Center at the University of Tokyo since 2003. He specializes in technology and operations management, as well as business administration. He holds a Ph.D. from Harvard Business School (1989), where he served as a researcher following graduation and later as a Visiting Professor (1996–7) and a Senior Research Associate (1997). He has also served as an Associate Professor on the Faculty of Economics at the University of Tokyo, a Visiting Professor at Lyon University, France and a Visiting Researcher at INSEAD.

Francesco Garibaldi is an industrial sociologist by education, a former Director of IPL, and is now a member of the scientific direction of IRES E/R (the Institute of Economic and Social Research, Emilia-Romagna), Bologna, Italy. His latest publications on the automotive industry are a book co-authored with P. Morvannou and J. Tholen (eds) *Is China a Risk or an Opportunity for Europe? An Assessment of the Automobile, Steel and Shipbuilding Sectors* (Peter Lang, 2008) and 'Le politiche industriali', in G. Volpato and F. Zirpoli (eds) *L'auto dopo la crisi*, (Francesco Brioschi Editore, 2011).

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