

# The emerging trajectory of electric mobility

A story of fits and starts

René Kemp

Presentation for  
**The Transition Pathways to a Low Carbon Economy**  
 Final dissemination Conference,  
 London, April 18, 2012



## 1960-2000: Different local initiatives

- In the **Swiss town of Mendriso** between 1995 and 2001 a large-scale market testing programme was used for electric mobility. The aim of the project was to demonstrate and evaluate the usefulness of LEVs and learn about promotion measures. By 2001 the project had helped to bring 396 EVs onto the roads, (174 cars, 20 Light duty vehicles, 97 scooters and 96 electric bikes). The programme heavily relied on subsidies (50 to 60% of the purchase price). When the subsidies ceased, the enthusiasm for EVs also faded away.
- La Rochelle (**France**): From December 1993 to December 1995, 50 inhabitants of La Rochelle tested 25 Peugeot 106 and Citroën AX. The goal of this large scale-operation was to test electric performance in an urban environment. In 1995, EV developments became integrated in the ELECTRIC AUTOPLUS electric car and scooter hire service for daily urban use (9 cars and 10 scooters). <http://www.eaue.de/winuwd/110.HTM>
- PIVCO a **Norwegian** small electric car for urban use.
- The most important initiative was the **Zero Emission Vehicle Mandate** in California during the 1990s, establishing new car sales requirements.

## The Zero Emission Vehicle Mandate in California

**Table 1. CARB requirements for manufacturer's fleet sales**

Model year	Conventional vehicle	TLEV	LEV	ULEV	ZEV
1994	90	10			
1995	85	15			
1996	80	20			
1997	73		25	2	
1998-2000	48		48	2	2
2001-2002			90	5	5
2003			75	15	10

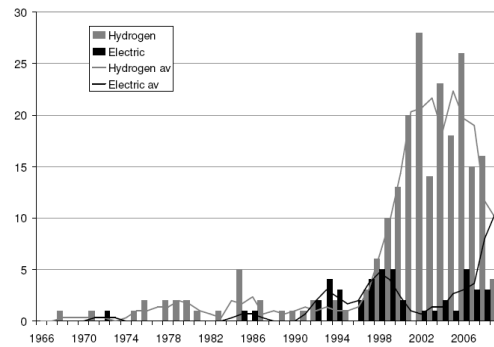
Source: Hoogma (2000, p. 257)

## *A changing window of opportunity*

- Following opposition from car manufacturers (with Japanese companies joining the American front) the Zero emission vehicles sales requirements were changed: they could be met **partly by hybrid electric vehicles** that meet the SULEV requirements.
- CARB backed from a confrontational approach in favour of a more **cooperative** approach.
- The window of opportunity that once existed for battery electric vehicles changed: the focus shifted from BEV to hybrid electric vehicles and hydrogen fuel cell vehicles

Kemp, R. (2005) Zero Emission Vehicle Mandate in California: misguided policy or example of enlightened leadership?, in: C. Sartorius and S. Zundel (Eds.) *Time Strategies, Innovation and Environmental Policy*, Edward Elgar, Cheltenham, pp. 169-191.

## Number of prototypes for hydrogen fuel cell vehicles and electric vehicles



Source: Bakker and van Lente (2009)

## Car companies involved in **electric vehicle** development in the 1990s

- In the early 1990s, a few **small companies** outside the (high volume) car industry were dominating EV-developments. These niche players adopted a different design for the car body, which depended less on economies of scale and allowed them to be profitable by selling only a few hundred vehicles.
- Large automakers opted for a low-risk, low-cost strategy of **converting** existing models into EVs.

Orsato, R.J., M. Dijk, R. Kemp and M. Yarime (2010) The Electrification of *Automobility*. The bumpy ride of electric vehicles towards regime transition, in *Automobility in Transition? A sociotechnical analysis of sustainable transport*, edited by F.W. Geels, R. Kemp, G. Dudley and G. Lyons, Routledge, New York, pp. 205-228.

*Electric vehicle experiment of 1990s largely failed ... but led to improved batteries and electric drivetrains which are now making comebacks in hybrids, fuel cell vehicles... and battery-electric vehicles!*

DCX GEMs in Factory, 2002

Toyota

Honda

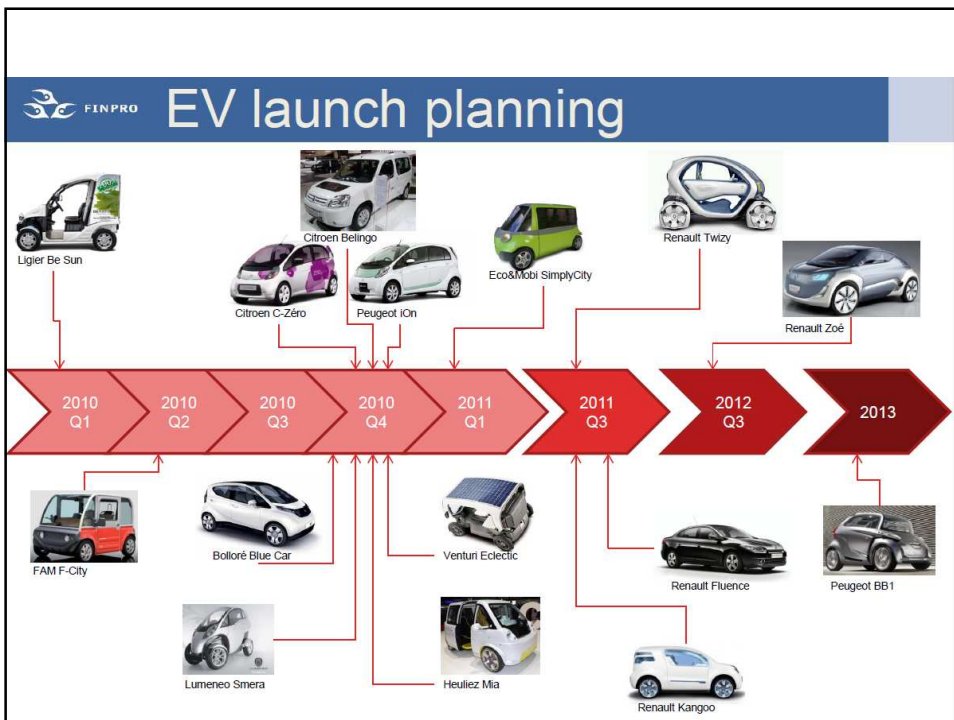
GM EV1

Bombardier

Pivco/Think

Nissan

Source: Sperling 2009



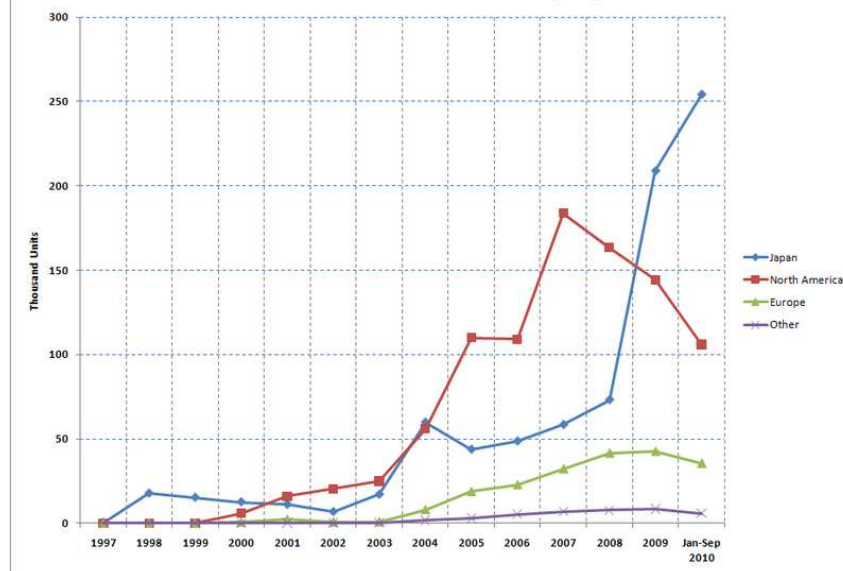
## The only electric vehicle success story: Toyota Prius and Hybrid Technology

Worldwide Annual Sales of Prius  
(Thousand units)

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Jan-Sep 2010	Cum. Total
Japan	0.3	17.7	15.2	12.5	11	6.7	17	59.8	43.7	48.6	58.3	73.1	208.9	254.2	826.9
North America	-	-	-	5.8	16	20.3	24.9	55.9	109.9	109	183.8	163.3	144.3	105.9	939.1
Europe	-	-	-	0.7	2.3	0.8	0.9	8.1	18.8	22.8	32.2	41.5	42.6	35.5	206.1
Other	-	-	-	0.01	0.2	0.2	0.4	1.9	2.9	5.3	7	7.7	8.4	5.8	39.7
<b>Total</b>	<b>0.3</b>	<b>17.7</b>	<b>15.2</b>	<b>19</b>	<b>29.5</b>	<b>28.1</b>	<b>43.2</b>	<b>125.7</b>	<b>175.2</b>	<b>185.6</b>	<b>281.3</b>	<b>285.7</b>	<b>404.2</b>	<b>401.3</b>	<b>2,011.80</b>

Source: <http://www.greencarcongress.com/2010/10/worldwide-prius-cumulative-sales-top-2m-mark-toyota-reportedly-plans-two-new-prius-variants-for-the-.html#more>

Worldwide Annual Sales of Prius by Region



Source: <http://www.greencarcongress.com/2010/10/worldwide-prius-cumulative-sales-top-2m-mark-toyota-reportedly-plans-two-new-prius-variants-for-the-.html#more>

## In Paris



### Case Autolib' - Paris Region

- Project of electric cars free sharing service in Paris Region 2011; First big European metropolis to create a self-service electric cars service
- In the beginning the service will include 3 000 electric cars and 1 000 recharge stations
- Invitation to tender launched by Syndicate of Île-de-France region and 27 other communities -> decision will be made end of 2010
- The winning bidder, a private operator, will not only build the infrastructure but also operate the program (infrastructure, maintenance, renewal of properties, insurance and Client relations service, logistic, Software /IT) — and will be responsible for finding a manufacturer to supply the electric cars
- 4 candidates in the final session:
  - 4 city (Avis, RATP, SNCF, VinciPark) with Smart
  - ADA with Citroën Czero
  - Bolloré with Bluecar
  - Veolia Transport with Peugeot iOn



## The Volt and Leaf



WEYB RANGES



- Attractive looking cars which sell at £25,990 and £17,850 (after £5,000 plug in car grant)
- Sales in year of introduction (2011): 17,000 units for the Chevy Volt and the Nissan Leaf, combined.

## Israel

- In January 2012, Better Place introduced its first 100 cars in Israel. The cars, all Renault Fluences have been specially built for running exclusively on electricity
- The cars will be available for a purchase price of ... and can be rented from two rental car companies.
- An infrastructure for charging and battery exchange will be provide by Better Place.



Source:  
<http://www.greenprophet.com/2012/01/better-place-israel-roads-100/>

## Contingency and structural forces

## ZEVM as a historical contingency

- In 1990 the Californian **Air Resources Board** (an **independent** regulatory agency) was working out a new programme of sales requirements for low-emission vehicles to deal with the problem of smog
- During the preparation of the programme there was the **demonstration** at the LA 1990 motor show of the **Impact electric vehicle** (*a concept car*) by GM, and announcement of GM a few months later that it would produce the Impact car suggesting that electric vehicles were economically viable
- Targets for zero emission vehicles were added, starting at 2% in **1998** (8 years from 1990)
- **The programme involved biannual reviews of technologies, giving leeway to industry**
- **In California environmentalists are policy insiders rather than outsiders**
- The policy wish to create a EV industry in California compensating for the loss of jobs in the aerospace and defence industry was an additional factor working in its favour

Source: Kemp (2005)

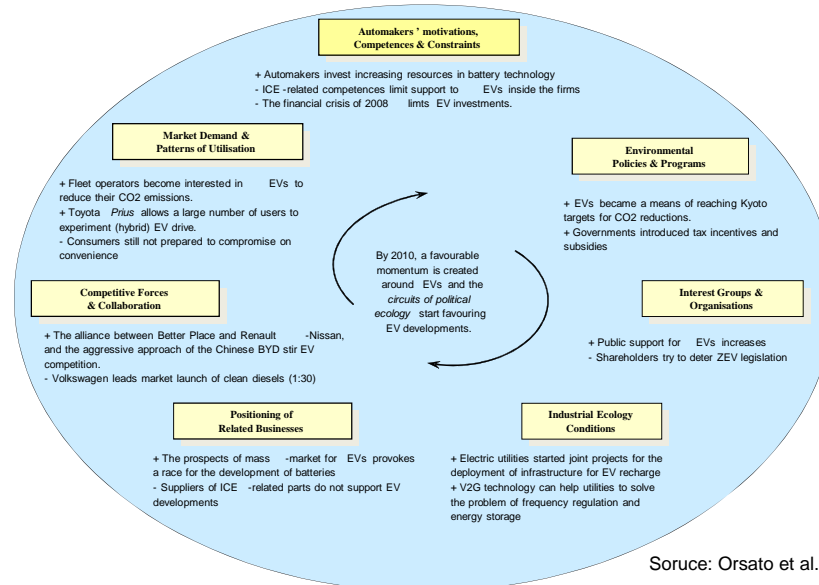
- *"Today if we tried to do the ZEV Mandate by itself it would be one of the hardest fights in the world. At the time it just kind of slipped through. People weren't looking at; I don't think they considered it real". (Elzen, 1995, p. 36).*



## A new momentum from 2000 on

- **Almost all major car manufacturers are developing cars with electric propulsion:** BEV, (P)HEV, FCV; some (Nissan and Renault) moved from a defensive to a (prudent) offensive strategy
- The European Commission has stimulated the development of alternative powertrain technologies through R&D programs (mainly via the 7th Framework), and England, Italy, Germany, and Japan introduced subsidies for the purchase of EVs. Denmark and Israel championed the incentives for EVs by exempting them of the taxes paid for ICEs.
- **Action plans** for electric vehicles from local authorities (Amsterdam) and public-private-CSO alliances.
- Electric mobility **leasing model** of Better Place in California, Israel and Denmark
- Recharging and battery swapping points are being put in place
- Electric **utilities** are getting involved in EV partnerships
- Joint ventures of car manufacturers with battery developers
- **Fleet owners** interested. In Amsterdam car2go electric car sharing initiative
- ...
- 

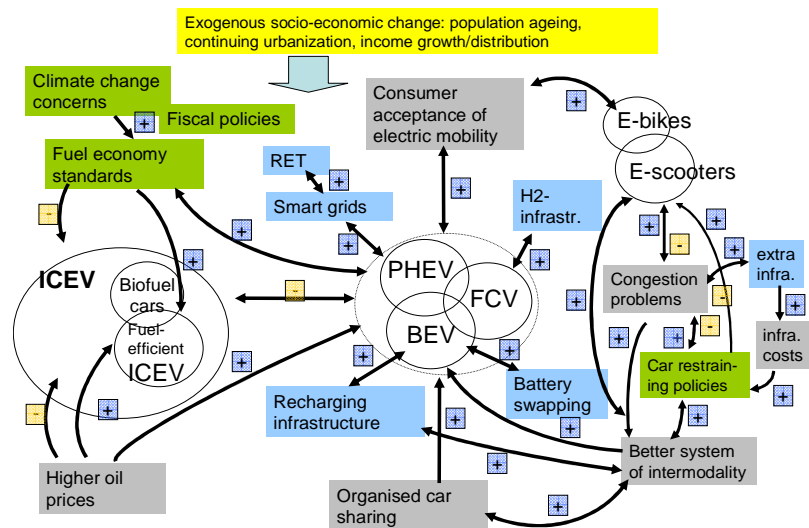
## A political ecology-based view looking at actors and ongoing developments



## Competitive and synergetic effects for EVs (determining its future)

- BEV, FCV and PHEV are competing with (fuel-efficient) ICEV
- Different configuration of electric mobility are competing with each other.
- Positive developments for *all* electric vehicles (battery, hybrid and fuel cell)
  - higher oil prices
  - better batteries and recharging systems,
  - new business propositions such as mobility leasing with battery swapping
  - urban policies to restrain car traffic and promote clean and silent cars
  - better systems of intermodality
  - cultural acceptance of electric mobility and organised car sharing.
- Rising oil prices will both stimulate EV and fuel efficient ICEV. The availability of cleaner ICE vehicles will slow down the diffusion of electric vehicles.
- Electrification of bicycles and scooters as a spill-over effect / neighbouring development.

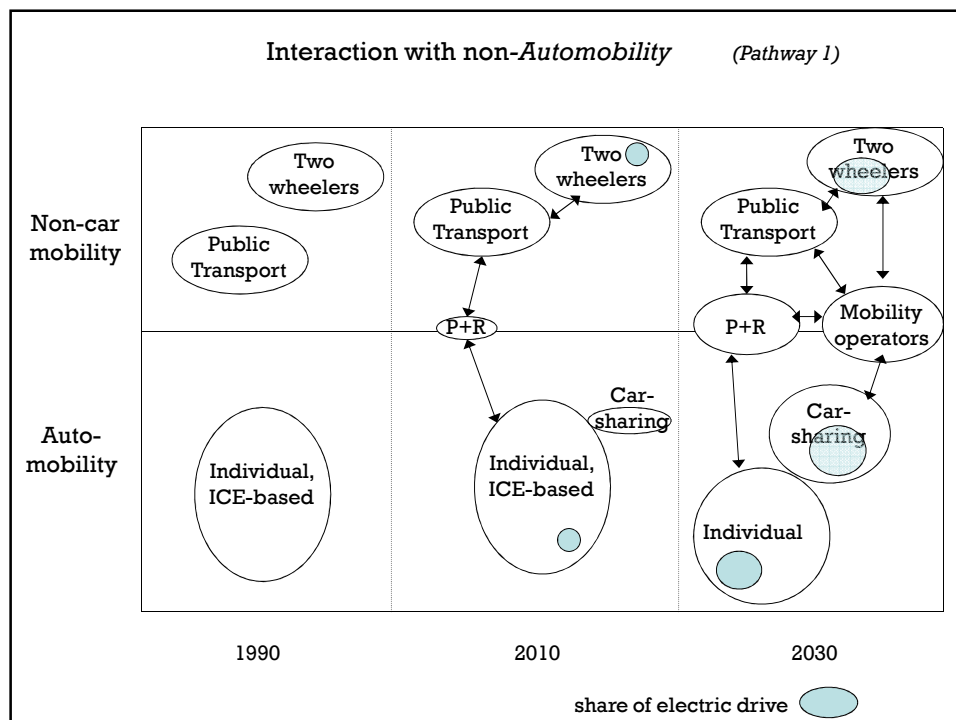
## Competitive (-) and synergetic (+) relationships



## Factors working *against* electric mobility

- High battery costs and short range
- The current dominance of cultural attachment to *owning* rather than renting vehicles;
- The commitment of car manufacturers to (environmentally improved) internal combustion engine (ICE) vehicles;
- Increasing sales and preference for cheaper ICE cars in emerging markets such as China, as compared to more expensive hybrid vehicles;
- Possibility that (hydrogen) fuel-cell technology will be ready for commercial use any time soon.

Orsato, R.J., M. Dijk, R. Kemp and M. Yarime (2010) The Electrification of *Automobility*. The bumpy ride of electric vehicles towards regime transition, in *Automobility in Transition?* pp. 205-228



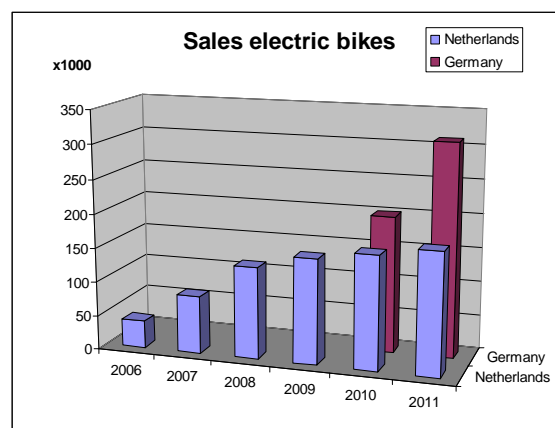
## The growing market for electric scooters and motorcycles

The market electric scooters and e-motorcycles is expected to increase from 17 million units in 2011 (mostly in China) to an estimated **138 million units by 2017**.

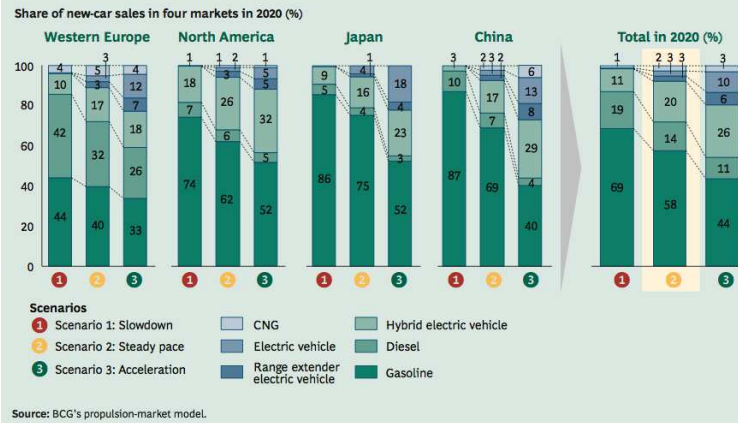
- Western Europe: 110,000 e-motorcycles, 92,000 e-scooters
- Pacific Asia: 2.7 mil e-motorcycles, 13.5 mil e-scooters
- China: 2.2 mil e-motorcycles, 19.5 mil e-scooters

Source: <http://gas2.org/2011/05/02/electric-motorcycle-and-scooter-sales-to-skyrocket/>

## In Netherlands 15% of new bicycles sold are e-bikes



**Exhibit 4. All Three Scenarios for 2020 Show ICE Technology Still Dominating Key Automotive Markets**



## Conclusions

- **Electric mobility has crossed a critical point: attractive vehicles, high fuel prices, CO2 regulations**
  - Niche for battery electric vehicles in **cities** and **fleets**
  - Niche for PHEV and HFCV as all-purpose **family cars**
- The development of electric mobility is **irreversible** but the **trajectory of green ICEV is much stronger, acting against electric mobility**
- While we are looking at cars, an **electrification in 2-wheelers** is happening (spreading rapidly in China but also in other countries)
- We are moving to a transport system with **greater variety**; electric vehicles, e-scooters, (public) bikes, car sharing (temporary state or new equilibrium?)

See Geels, F.W. Kemp, R., Dudley, G., and Lyons G. (eds.) (2012), *Automobility in Transition? A sociotechnical analysis of sustainable transport*, Routledge, New York.