Mission-oriented R&I policies: In-depth case studies

Case Study Report

New Energy Vehicles (China)
Case Study Report: New Energy Vehicles (China)

European Commission
Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination
Unit A.6 — Open Data Policy and Science Cloud

Contact  Arnold Weiszenbacher
E-mail  arnold.weiszenbacher@ec.europa.eu

European Commission
B-1049 Brussels

Manuscript completed in February 2018.

This document has been prepared for the European Commission however it reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.


Luxembourg: Publications Office of the European Union, 2018


Reuse is authorised provided the source is acknowledged. The reuse policy of European Commission documents is regulated by Decision 2011/833/EU (OJ L 330, 14.12.2011, p. 39).

For any use or reproduction of photos or other material that is not under the EU copyright, permission must be sought directly from the copyright holders.
Mission-oriented R&I policies: In-depth case studies

Case Study Report

New Energy Vehicles (China)

Antti Pelkonen

vTT

JIIP

A Study coordinated by the Joint Institute for Innovation Policy

February 2018

Directorate-General for Research and Innovation
# Table of Contents

1 Summary of the case study ........................................................................................................... 1 
2 Context and objectives of the initiative ....................................................................................... 7 
   2.1 Contextual factors and origins of initiative ......................................................................... 7 
   2.2 Strategic and operative objectives and milestones of the initiative ................................ 9 
3 Resources and management ........................................................................................................ 11 
   3.1 Governance and management model ............................................................................... 11 
   3.2 Financing model ................................................................................................................ 12 
   3.3 Key actors involved in the initiative .................................................................................. 12 
   3.4 Monitoring system and evaluation of the initiative .......................................................... 14 
   3.5 Level and type of citizen engagement in the initiative ...................................................... 15 
4 Policy instruments and wider policy-mix used for implementing the initiative ................. 16 
   4.1 Description of the R&I policy instruments used for implementing of the initiative .... 16 
   4.2 Connections with other policies ..................................................................................... 17 
   4.3 Key turning points of the initiative and policy adaptation measures ............................. 19 
5 Realised or expected outputs, outcomes and impacts .............................................................. 21 
   5.1 Outputs and new instruments ......................................................................................... 21 
   5.2 Outcomes ........................................................................................................................ 21 
   5.3 Impacts ............................................................................................................................. 22 
   5.4 Summary of the key indicators ...................................................................................... 26 
6 Conclusions and lessons learned .............................................................................................. 27 
   6.1 Identification and assessment of key strengths and weaknesses of the initiative ........ 27 
   6.2 Lessons learned and key messages for European R&I policy ........................................ 27 
References ..................................................................................................................................... 29
1 Summary of the case study

This case study analyses the Chinese New Energy Vehicle (NEV) policy approach from the perspective of mission-oriented R&I policy. The following table describes the main components of the study:

<table>
<thead>
<tr>
<th>Summary fiche</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>New Energy Vehicles (NEVs)</td>
</tr>
<tr>
<td>Country:</td>
<td>China</td>
</tr>
<tr>
<td>Thematic area:</td>
<td>Transport</td>
</tr>
<tr>
<td>Objective(s):</td>
<td>The current objective of China’s New Energy Vehicle policy is to have five million NEVs (i.e. cars that are either partially or fully electric) on the roads by 2020 and that by 2025 at least one in every five cars sold in China is a new energy model.</td>
</tr>
<tr>
<td>Main governing body:</td>
<td>The central of government of China, and in particular the Ministry of Science and Technology (MOST), the National Development and Reform Commission (NDRC) the Ministry of Industry and Information Technology (MIIT) and the Ministry of Finance (MOF).</td>
</tr>
<tr>
<td>Timeline:</td>
<td>2001-2020 / 2025</td>
</tr>
<tr>
<td>Budget:</td>
<td>The NEV policy has been running for nearly 20 years and it has been implemented through various types of policy instrument. Hence there is not, and largely cannot be, any official estimation of the overall budget used for it. However, it is obvious that the overall budget of policies related to NEV development in China has been hundreds of billions of euro. It has been estimated that, for instance, that between 2015-2020 China spent USD 60 billion (EUR 51 billion) only on NEV subsidies (from both central and regional government) and RMB 25 billion (EUR 3.2 billion) in network charging stations (Cliver 2017). R&amp;D programmes in the NEV area have amounted to at least EUR 2 billion.</td>
</tr>
<tr>
<td>Brief description of the case (250 words)</td>
<td>With the aim of addressing energy security problems (dependence on imported oil), urban air pollution concerns emerging from rapid growth of vehicle population as well as challenges of economic upgrading, China has invested heavily on the development of new energy vehicles (NEVs) since early 2000s. The Chinese NEVs policy aims at a large-scale systemic transition in transport. The current target of the Chinese government is to have five million NEVs on the roads by 2020 and that by 2025 at least one in every five cars sold in China will be a new energy model.</td>
</tr>
</tbody>
</table>

China’s NEV development is implemented in a top-down approach. The central government has been the initiator and main driver for the NEV mission. The central government supports all stages of the development from R&D, demonstration and promotion, commercialisation to production and sales, scale-up, and charging infrastructure construction. In order to respond to policies of central government, local governments also provide support to NEV production and sales, and charging infrastructure construction. In particular, some provincial governments have become important advocates and stakeholders in the NEV development and supported its development. Local governments have procured NEVs and in some cases also subsidised cars sold to private buyers. However, the role of market in the NEV transition has thus far been relatively weak. So far, the subsidy policy of government has the main driver of EV enterprises to produce EVs and consumers to buy NEVs (OECD 2014).
**Summary fiche**

NEV is a very complex and multifaceted policy which targets a system transition and involves a large number of stakeholders and actors across various levels of government and across different regions of the country. In this complex setting, the central government has been in the leading position of the mission from the outset. At the central government level, horizontal coordination of NEV policy mainly takes place through the Inter-Ministerial Joint Committee on Energy-Saving and New Energy Automobile Industry Development. It is led by the Ministry of Industry and Information Technology (MIIT) and includes another 17 ministries.

The Chinese policy to promote NEVs has included both supply- and demand-side measures. Supply-side measures include: R&D projects supported under national S&T programs, support for commercialisation of electric vehicles and their components, tax credit to car manufacturers and fiscal reward to charging infrastructure construction. Demand-side measures include: subsidies for purchasing NEVs, regulation such as restrictions on licence plates for combustion engine cars, tax reduction for purchasing NEVs, public procurement and setting standards for electric vehicles. Furthermore, recently it has been announced that the Chinese government is working on a timetable to ban the manufacture and sale of cars with traditional fuel engines (Heller 2017).

<table>
<thead>
<tr>
<th>Observed / expected outputs, outcomes, and impacts</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Source for the figures in this section: OECD 2014)</td>
<td>At least the following outputs can be identified:</td>
</tr>
<tr>
<td></td>
<td>• Hundreds of research and development projects (e.g. 270 projects under the <em>Energy-Saving and New Energy Vehicle Major Project</em> (2006-2010) and 77 projects under the <em>Electric Vehicle Key Technology and System Integration Major Project</em> (2010-2015));</td>
</tr>
<tr>
<td></td>
<td>• NEV R&amp;D platforms (at least 48) and public inspection and test platforms (at least 7));</td>
</tr>
<tr>
<td></td>
<td>• National standards (at least around 80);</td>
</tr>
<tr>
<td></td>
<td>• 15 key national laboratories and engineering technology research centres built</td>
</tr>
<tr>
<td></td>
<td>• Demonstration operations and projects (large number of cities);</td>
</tr>
<tr>
<td></td>
<td>• Hundreds of patent applications (at least around 3000).</td>
</tr>
</tbody>
</table>

**Outcomes**

At least the following outcomes can be identified:

The national capacity and technological knowhow in the NEV area has substantially developed in China. Following the NEV policy, hundreds of NEV models have entered Chinese national auto announcement directory (at least 350). For instance, in 2016, 25 new NEV models were introduced to the Chinese market. In particular, in the last couple of years, Chinese NEV industry has progressed substantially.
In more concrete terms, the following dimensions of NEV technology have been mentioned as areas where China has made significant progress (OECD 2014):

- **PHEV** (plug-in hybrid vehicles) technology made important progress. Some PHEV models are close to an international advanced level;
- **BEV** (battery electric vehicles) technology is increasingly matured and ready to commercialise. Some Chinese automakers have mastered the core technologies in vehicle powertrain matching and integration, and vehicle control. They have capability to develop BEVs close to an international advanced level;
- Significant progress has been made in **FCV** (fuel-cell vehicle) technology. So far, China has preliminarily grasped core technologies in finished vehicle, power system and key components; built up BEV powertrain technology platform with own intellectual property rights; formed a complementary research system of key components, including the fuel cell engine, power batteries, DC/DC converter, drive motor, and hydrogen storage and supply;
- Progress has been made in key components. In terms of power battery, Chinese automakers have preliminarily had product research and development capabilities and production equipment design and manufacturing capabilities. Power battery performance has gradually reached an international advanced level. There is Chinese production in lithium ion battery anode materials and electrolyte. In terms of drive motor system, the main technical indicators have reached an international level. In electric control system, China has initially formed small batch production ability of hybrid system and pure electric drive system.

**Impacts**

It is quite evident that to date China has not reached its mission targets in terms NEV penetration and transformative change, and according to current estimates will not reach the current goals by 2020 or 2025.

The numbers of sold NEVs in China have been relatively low compared to the targets (Howells et al. 2014). For instance, the target of 500 000 NEVs by 2015 was not reached (OECD 2014, 14); in 2014, China produced 78 499 EVs and sold 74 763 which was up 9.4 times and 9.2 times over the period of 2011 respectively. However, in recent years the pace of growth has accelerated: in 2016 around 330 000–350 000 NEVs were sold in China. As a result, China has become by far the largest electric car market in the world.

According to the current estimates, in 2017 number of sold NEVs will rise to around 410 000 NEVs in China which would correspond to over 40% of global sales. It has been estimated that by 2025, 4.2 million NEVs would have been sold in China.
The environmental impacts of China’s New Energy Vehicle policy are debatable. With respect to environmental and climate impacts of electric vehicle transition, the carbon intensity of electricity grids is of great significance. In China, where almost 90% of power derives from fossil fuels (and 70% from coal), the carbon intensity of grids is very high. Hence, it is somewhat unclear what the impact of the proliferation of electric cars in China is and will be on CO2 emissions. It has been argued that the prediction of NEVs in terms of reducing CO2 emissions is not very positive and that reducing CO2 emissions could only take place if coal combustion technologies improve and the share of non-fossil electricity increases significantly in the country.

### Summary fiche

**Directionality (links to societal challenges, industry transformation):**

Yes. Chinese NEV policy is directly linked to certain societal challenges as well as industry transformation. In terms of societal challenges, NEV policy is means to tackle China’s pollution problems and carbon emissions. With respect to industry transformation, NEVs is a clear element in China’s attempt to upgrade its industry and economy to adopt a role in the global economy which is based on higher value and higher technology. Overall, economic and industrial upgrading has been the main driver in China’s NEV policy.

**Intentionality (specific, well-articulated goals):**

Yes. The goals of NEV policy in China have been quite clearly articulated and quantified. For instance, the current goal is to have five million NEVs on the roads by 2020 and that by 2025 at least one in every five cars sold in China is a new energy model. However, the targets have been to some extent modified over time probably due to the fact that the original goals have not been achieved in the planned schedule.

**Clearly set timeline and milestones:**

To certain degree. There have been the overall goals and targets for the NEV penetration and a set timeline. On the basis of available material, it is difficult to assess whether milestones have been clearly set on the outset.²

**Mobilises public and private investments:**

Yes. Public investments in China’s New Energy Vehicles programme have been significant, in particular in by the central government but also to some extent local governments. Public investments have taken various forms such as R&D programmes and projects, subsidies to car manufacturers and consumers, public procurement, etc. Chinese NEV companies have also started to invest increasingly in R&D.

**Focused on new knowledge creation (basic research, TRLs 1-4):**

Yes. From the outset China’s NEV policy has had the target of upgrading the Chinese capabilities in the area of electric vehicles and this has included large R&D programmes and projects comprising also basic research.

**Focused on knowledge application (applied research, TRLs 5-9):**

Yes. Applied research and application of knowledge has had a firm role in this initiative which is demonstrated, e.g. in the number of new NEV models that have entered the market during the NEV policy in China.

---

1 Assessment: Yes, To certain degree, No or Not known.
2 Access to original policy documents has been limited as they are almost uniquely in Chinese.
<table>
<thead>
<tr>
<th>Summary fiche</th>
<th></th>
</tr>
</thead>
</table>
| **Demand articulation** (involves instruments for inducing demand): | **Yes.** The following demand-side instruments have been used:  
- Subsidies for purchasing NEVs: Consumers who purchase NEVs can get subsidies from the government. This has been in place at least since 2013 but most probably already earlier;  
- Tax reduction for purchasing NEVs: Purchasing BEVs, PHEVs and FCVs are exempted from tax on vehicles and vessels;  
- Public procurement: China’s NEV policy has relied strongly on government procurement of NEVs (Howells et al. 2015, 8). In 2014, the National Government Offices Administration announced a measure that electric cars make up at least 30% of government vehicle purchases by 2016. Central government ministries and agencies are expected to take the lead on purchases of BEVs, PHEVs and FCVs. The ratio will be raised beyond 2016, when local provinces are required to meet the target;  
- Setting standards for electric vehicles: China has established a sound NEV standard system with 78 published NEV standards. Among them, 28 are the standard of the finished vehicle and general standards, 24 are standards of power battery and key assembly standards, 26 are standards of charging infrastructure standard. Yet, different NEV enterprises understand differently these standards, which resulted in incompatible products. Furthermore, China has cooperated with Germany in developing and publishing standards. China and Germany jointly promote standards on DC charging, charging interface, and communication protocol to become international standards.  
- Demonstrations and pilots |
| **Multi-disciplinary (inter-disciplinary and/or trans-disciplinary):** | **Yes / To a certain degree.** NEV policy mainly concerns various types of energy technologies but also engineering technologies in broader terms, hence a sort of interdisciplinarity is manifested yet perhaps not transdisciplinarity. |
| **Joint coordination (multi-level and/or horizontal governance of policies/finance):** | **Yes.** As a large-scale initiative, NEV policy in China has required both vertical and horizontal coordination across levels and sectors of government. In terms of horizontal coordination, four sectors (ministries) have been the most central and they have jointly defined the broad policy framework for NEVs: Ministry of Science and Technology (MOST), the National Development and Reform Commission (NDRC), the Ministry of Industry and Information Technology (MIIT) and the Ministry of Finance (MOF). In practice, cross-sectoral, horizontal coordination has been on the responsibility of the Inter-Ministerial Joint Committee on Energy-Saving and New Energy Automobile Industry Development, led by the Ministry of Industry and Information Technology (MIIT) and including another 17 ministries.  
NEV policy in China has predominantly been implemented as top-down policy driven by the central government. The central government has been on driver, initiator and coordinator of the policy, but at the same time local governments have also had an important role. In particular, some provincial governments have become important advocates and stakeholders in the NEV development and supporting its development. Local governments have procured NEVs and in some cases also |
<table>
<thead>
<tr>
<th>Summary fiche</th>
<th>subsidised cars sold to private buyers (Howells et al. 2015.). Hence, multi-level governance and the interplay between central and local governments have been important.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflexivity (flexible policy design, timely monitoring):</td>
<td><strong>To some degree.</strong> Over the years the course of the NEV policy has already been changed a few times, and it seems that the Chinese top-down governance model enables re-steering and altering the course of the policy along its development. The key numerical targets (e.g. number of sold/produced NEVs) are easily monitored. Many of the targets of NEV policy have been put forward in key documents of the Chinese economic and societal development, such as the National Middle to Long Term Plans for Science and Technology Development or the Five-Year Plans, and hence the target setting process as well as the monitoring is likely to be closely linked to the formulation of such plans.</td>
</tr>
<tr>
<td>Openness (connected to international agendas and networks):</td>
<td><strong>No.</strong> Electric vehicles are being developed around the globe in many countries. However, the Chinese approach has been very much inward-looking which is reflected e.g. in trade practices. For instance, significant trade barriers have been set to prevent foreign NEV technology from entering the Chinese market. Although China decreased tariffs and eliminated import quotas in the mid-2000s to meet WTO accession commitments, it still maintains a 25% import tariff on vehicles. Furthermore, since 2009 extremely stringent trade barriers have been erected against foreign automakers in an effort to induce technology transfer and promote innovation among domestic firms. Such restrictions create strong incentives for foreign firms not to share with or transfer their technological expertise to Chinese firms. Chinese car manufacturers have established joint ventures with foreign companies but so far these have not led to such technology transfer that the Chinese have hoped for. Hence, China’s EV industry has thus far been comparatively isolated (Howells et al. 2015).</td>
</tr>
<tr>
<td>Involvement of citizens:</td>
<td><strong>No.</strong> NEVs initiative in China has been strongly government led and top-down driven. It seems that citizens are mainly seen and regarded as consumers and potential buyers of new energy vehicles. It seems, however, that overall NEVs policy has been quite widely communicated and it has received much attention, e.g. through local and regional programmes and for instance through large-scale events such as the Beijing Olympic Games.</td>
</tr>
</tbody>
</table>
2 Context and objectives of the initiative

This chapter discusses the background, context and objectives of the China’s new energy vehicles policy. It also provides a detailed timeline of the progress of the policy and its main phases from its start in the early 2000s up to today.

2.1 Contextual factors and origins of initiative

The New Energy Vehicles policy in China can be seen as an attempt to address several challenges that the country has been facing: energy security (to overcome dependence on foreign countries in terms of energy supply and oil in particular), pollution and the environment (health and environmental consequences of energy use have become barriers to further economic growth), and economic and technological upgrading (the need to upgrade industry to higher-value, higher-technology role in the global economy (Howells et al. 2015). In the following, these main driving forces and contextual factors behind China’s NEV policy are discussed in more detail (largely based on Howells et al. 2014, 4-5).

1. Economic and technological upgrading. The Chinese Communist Party (CCP) believes that sustainable economic growth depends on upgrading industry to a higher-value, higher-technology role in the global economic supply chain. This was manifested in the National Middle to Long Term Plan for Science and Technology Development 2006–2020 (MLP) in 2006, in which the government set the goal to make China a world-leading innovation country and in which ‘indigenous innovation’ became the core of the national innovation strategy (Liu et al. 2017). The car industry has been a fundamental factor in China’s visions of becoming a global economic power. In the views of the government, EV production and sales could play a prominent role in China’s strategy to achieve this vision. The party argued that building a large domestic market would offer a launch pad for global expansion, and enable China to attain commercial lead in a potentially valuable global growth sector. In contrast to gas-powered cars, where established foreign competitors would be hard to challenge, authorities argued that battery technologies offered an opportunity to leapfrog foreign competitors.

2. Energy security. For most of the last three decades, energy security has been a military and economic priority for China. Since 1993, China has been a net importer of oil and will soon pass the U.S. to become the world’s largest oil importer. Today, over 50% of oil consumed is imported, with transport accounting for around 25% of final consumption. Over 60% of imported oil originates in the Middle East and travels through the Malacca Straits, a potential strategic choke point that could be blocked by powers hostile to China. According to the Ministry of Industry and Information Technology (MIIT), new vehicle sales are responsible for 70% of China’s annual growth in gasoline and diesel consumption. Concerned about supply disruptions, China has made development of indigenous energy resources, both conventional and renewable, a priority. Thus, electrifying the transport sector, which in the near term would rely on electricity generated from domestic coal, could enhance China’s energy security (but would simultaneously increase air pollution and reduce public health).

3. Carbon emissions. Reduced carbon emissions, and greater energy efficiency were important elements in China’s 12th Five-Year Plan (2011-2015). Published in March 2011, the Plan included targets to decrease the energy intensity of the economy by 16% by 2015.
with a 17% reduction in accompanying carbon emissions (on a 2005 baseline). These are interim targets on the way to a pledged 40-45% reduction in carbon intensity by 2020. Electric vehicles are seen as contributing to this goal, despite the fact that EVs almost certainly cause higher CO2 emissions in certain regions than conventional cars.

4. **Local pollution reduction.** China houses seven of the world’s ten most air-polluted cities and hence China’s government focus on EVs also as a means to reduce local urban pollution. NEVs can offer urban air pollution reduction without abandoning the personal automobile.

Among these drivers, technological and economic upgrading has had precedence over the three others in China’s NEV mission (Howells et al. 2015, 9). If environmental or energy factors had dominated, the design and implementation of the policy would have been different.

Drivers as well as barriers related to China’s NEV mission and policy are summarised in Table 1 below.

| Table 1. Drivers and barriers related to China’s NEV policy. |
|-------------------------------|-----------------------------|
| **Drivers**                  | **Barriers**               |
| Political                     |                             |
| • The need to diminish the dependence on foreign sources of energy. | • Trade barriers preventing foreign companies to share and transfer technological expertise with Chinese firms. |
| • China’s vision of becoming a global economic power. NEVs as a key element in achieving this vision. |                             |
| Economic                      |                             |
| • The perceived need to upgrade the Chinese economy. | • The scattered nature of Chinese car industry (large number of players). |
| • Lack of eagerness of Chinese carmakers to produce NEVs. | • Lack of eagerness of Chinese carmakers to produce NEVs. |
| Societal                      |                             |
| • The need to reduce carbon emissions and local pollution. | • Consumers not particularly willing to buy NEVs. |
| Technological                 |                             |
| • Chinese government’s understanding that domestic companies are able to leapfrog foreign competitors in NEV technology. | • Relative backwardness of Chinese car industry in terms of design, engineering, assembly and quality control competences. |
| Legal                         |                             |
| • Inadequate intellectual property protection. |                             |
2.2 Strategic and operative objectives and milestones of the initiative

As mentioned above, New Energy Vehicles policy addresses several key challenges China has been facing: the need for technological and economic upgrading, energy security, carbon emissions and local pollution reduction. From mission-oriented perspective, NEVs policy can be interpreted as a ‘tool’ to tackle and find solutions these challenges. Of these overall drivers, technological and economic upgrading has been considered the most important as a background factor for the NEV policy.

NEVs policy was initiated in early 2000s and it was intended, literally, to promote the industrial development from zero to industrialisation in 20 years. In terms of quantified targets, the concrete objectives have changed to some extent over time. For instance, in 2009, the goal was set that China should produce 500 000 NEVs by 2011 (5% of total vehicle sales) and battery production capacity should achieve 10 billion AH (Amp Hours) (Nieuwenhuis & Lin 2010). In 2011, in MOST’s Five-Year Plan for electric vehicles, this target was pushed forward to 2015 (deployment of 500 000 NEVs by 2015). This plan also set the target of having 2000 charging stations with 400 000 individual charging poles in place over the following five-year period (Howells et al. 2015, 9).

The current target of China’s NEV policy is to have five million NEVs on the roads by 2020 and that by 2025 at least one in every five cars sold in China will be a new energy model. In terms of charging infrastructure, China aims to deploy, by 2020, 4.3 million private EVSE outlets (EV charging stations, electric recharging points or charging points), 0.5 million public chargers for cars and 850 intercity quick-charge stations (IEA 2017).

Key policy developments and milestones

Key events in China’s policy to support New Energy Vehicles can be summarised as follows (OECD 2014; for a comprehensive timeline of NEV policy in China, see also Howells et al. 2015, Appendix A; and Niewenhuis & Lin 2015):

- In 2000, China started to emphasise reduced energy use and emissions in its car industry policy instead of just expanding production and localising supply chains (Howells et al. 2015, 7).

- In 2001, China started to promote electric vehicles as the Ministry of Science and Technology (MOST) launched the Electric Vehicle Special Project under the Tenth Five-Year (2001-2005) National High-Tech R&D Programme (863 Programme). The project covered hybrid-electric vehicles (HEVs), battery-electric vehicles (BEVs) and fuel-cell vehicles (FCVs), and multi-source energy power control unit (PCU), drive motor system, and battery and battery management systems (BMS). The project implied that China’s electric vehicle industry started a phase of fully fledged development.

- In 2006, “indigenous innovation” was raised in a central position China’s economic development plan as put forward in the National Middle to Long Term Plan for Science and Technology Development 2006-2020 (MLP) (Howells et al. 2015).

- In 2006, the MOST launched the Energy-Saving and New Energy Vehicle Major Project under the Eleventh Five-Year 863 Programme, which continued previous programmes’ framework with the focus on the NEVs’ power system technology platform and key components.
• In 2008, during the Beijing Olympic Games, 595 BEVs, HEVs and FCVs were used to serve the Games. This implied the largest scale of pilot operation of electric vehicles in the history of Olympic Games with an accumulated running distance of 3.71 million kilometres and total passenger transportation of 4.42 million person-times.

• In 2009, there was a turning point in China’s approach as the government started to focus on rapid deployment. The State Council issued the Auto Industry Restructuring and Revitalisation Plan (2009) which put forward the new energy auto industry strategy for the first time and proposed to invest RMB 10 billion (1.3 billion euros) for the industrialisation of new energy vehicles. In January 2009, 13 cities (including e.g. Beijing and Shanghai) were chosen as pilot cities for promoting the usage of new energy vehicles in the public sector ("Ten Cities, Thousand Cars" programme). In 2010, the list of pilot cities was extended with 12 new cities. Moreover, personal purchasing new energy vehicle would be subsidised in six cities.

• In October 2010, new energy vehicles were listed as one of seven strategic emerging industries by the State Council in the 12th Five-Year Plan.

• In March 2012, the MOST published the Twelfth Ten-Year Special Plan for Science and Technology Development of Electric Vehicle which aimed at making China as one of advanced countries in energy-saving and new energy vehicle industry through research, development and innovation.

• In June 2012, the State Council issued the Plan of Energy-Saving and New Energy Vehicle Industry Development (2012-2020) which confirms that the BEV is the main direction of new energy vehicle industry development. It adapted a phased introduction of electric vehicles and set a goal for electric vehicle industry development in various phase. The Plan targeted the production of 500 000 BEVs (battery electric vehicles) and PHEVs (plug-in hybrid vehicles) by 2015, with the production capacity to grow to 2 million units and the cumulative production and sales of more than 5 million of those types by 2020.

• In September 2013, a new round of promotion and application of new energy vehicles were launched. So far, total 39 city (clusters) or regions were identified to promote the application of new energy vehicles.

• In 2017, Chinese government has announced that it is working on a timetable to ban the manufacture and sale of cars with traditional fuel engines (Heller 2017).
3 Resources and management

This Chapter examines the governance and management of the Chinese NEV policy and key players in the development. It also discusses its financing aspect and provides some budget figures even though it is not possible to provide an exact and precise overall budget for such a large and encompassing policy approach.

3.1 Governance and management model

China’s EV development is implemented in a top-down approach. The central government has been and is the initiator and main driver for the EV development. In practice, the central government supports every stage of the system from R&D, demonstration and promotion, commercialisation to production and sales, scale-up, and charging infrastructure construction. In order to respond to policies of central government, local governments also provide support to EV production and sales, and charging infrastructure construction. In particular, some provincial governments have become important advocates and stakeholders in the NEV development and supporting its development. Local governments have procured NEVs and in some cases also subsidised car sold to private buyers (Howells et al. 2015). The role of market in transition has been relatively weak (see section 3.3 for more details). So far, the subsidy policy of the government is the main driver of EV enterprises to produce EVs and consumers to buy EVs (OECD 2014, 14-15).

In the central government, various sectors and ministries have been involved in the NEV policy in China requiring cross-sectoral coordination across various actors. In this regard, key actors have been the Inter-Ministerial Joint Committee on Energy-Saving and New Energy Automobile Industry Development. It was established in December 2013 by the State Council and it is led by the Ministry of Industry and Information Technology (MIIT) and includes other 17 ministries and agencies, being the National Development and Reform Commission (NDRC), the Ministry of Science and Technology (MOST), the Ministry of Finance (MOF), the Ministry of Public Security, the Ministry of Environmental Protection, the Ministry of Housing and Urban-Rural Development (MHURD), the Ministry of Transport, the Ministry of Commerce, People’s Bank of China, the State-Owned Assets Supervision and Administration Commission, the General Administration of Customs, the State Administration of Taxation, the General Administration of Quality Supervision, Inspection and Quarantine, China Banking Regulatory Commission, China Securities Regulatory Commission, China Insurance Regulatory Commission, and the National Energy Administration (NEA). The members of the Committee are officials at the vice-ministerial level or higher (OECD 2014).

The Joint Committee strengthens the overall guidance of the new-energy automotive industry, especially of the NEV industry, facilitate the implementation of related policies, and coordinate major issues regarding the industry development. The Committee has played an important role in resolving major obstacles in NEV industry development. For example, in order to speed up the construction of charging infrastructure, under the Committee the MOF introduced a new award to NEV charging infrastructure construction, the MHURD has formulated a plan of new energy automobile charging infrastructure, and the NEA has been leading the development of an electric vehicle charging infrastructure development plan (2015-2020). The Committee works to avoid the conflict of policy measures of different ministries and improve the compatibility of policies. (OECD 2014.)
3.2 Financing model

The NEV policy has been running for nearly 20 years and it has been implemented through many different types of policy instruments with variation over time. Hence there is not, and largely cannot be, any official (or even unofficial) estimation of the overall budget used for it. However, it is obvious that the overall budget of policies related to NEV development in China has been (hundreds of) billions of euro. It has been estimated that, for instance, between 2015-2020 China spent USD 60 billion (EUR 51 billion) only on NEV subsidies (from both central and regional government) and RMB 25 billion (EUR 3.2 billion) in network charging stations (Cliver 2017).

The overall budgets of all Chinese public NEV R&D programmes are not available but some estimations can be provided. For instance, during the 10th and 11th Five-Year Plans (2001-2005 and 2006-2010) nearly RMB 14 billion (EUR 1.8 billion) were invested in NEV R&D through the 863 programme. During the 12th Five-Year Plan (2011-2016) at least RMB 738 million (EUR 95 million) were invested through 863 Programme. In addition to the public investments, also car manufacturers have started to increase their investments in R&D, already during the 10th Five-Year Plan.

In order to put the Chinese NEV R&D investments in a larger perspective, they can be roughly compared with EU R&D funding on EVs. According to a JRC report (Zubaryeva & Thiel 2013), between 2007-2015 there were around 320 EU projects related to electric vehicles with a total public funding of around EUR 1 billion (hence roughly EUR 110 million per year on average). Hence, in this perspective the Chinese R&D investments on NEVs seem to be to some extent – but not dramatically – larger than EU investments. Indeed, some analysts have suggested that China should increasingly transfer public funding in support of NEVs from purchase subsidies to research and development as technology still seem to be the major bottleneck in the development of NEVs in China (Ma et al. 2017).

3.3 Key actors involved in the initiative

Several branches of the national government are closely involved in the management of innovation in the Chinese NEV industry. There are four key actors at the highest level of central government that jointly define the broad policy framework for NEVs. The first is the Ministry of Science and Technology (MOST), which has been responsible for the coordination of research efforts in the NEV area since the late 1990s. The National Development and Reform Commission (NDRC) has responsibility for strategic policy and long-term investment issues in a wide variety of areas. The Ministry of Industry and Information Technology (MIIT) sets the standards for NEVs as well as for testing and quality control. With the increasing volume of investments in the NEV industry, the Ministry of Finance (MOF) has also become directly involved in the policy-making process. Each of these four actors holds central positions in the Chinese decision-making system, and it is difficult to distinguish any clear hierarchical relations between them. In addition, several other ministry level organisations are involved in the sector’s development (Liu & Kokko 2013).

---

3 This calculation has to be considered as indicative at best, as data on Chinese R&D programmes and their budgets may be incomplete.
Both provincial and municipal governments are also involved in the development of the NEV industry (albeit with large regional differences). Some provincial governments have emerged as important stakeholders in the industry’s innovation system. The main motives for local policy makers to support the industry’s development are ownership linkages. While the largest Chinese auto enterprises are “owned” by the national government, there are also several companies that are owned by provincial authorities (Liu & Kokko 2013).

Besides the central, provincial and municipal governments, the most prominent actors are the car manufacturers, who carry out a substantial share of the research and production (often with funding from various government programmes). The research network also includes the major research universities and other research institutes. Other notable actors are suppliers of parts and components, as well as some industry organisations. However, it should be noted that most of the companies involved in the NEV industry, as well as the research organisations and industry associations, are also part of the public sector, being wholly or partly owned by the government. Hence, the private sector plays a less important role than in most other countries: few of China’s prominent car companies are privately owned, and private consumers have a relatively weak position (Liu & Kokko 2013). Figure 1 below illustrates some of these main actors.

Currently the most important Chinese NEV companies include the following (Barnard 2017):

- **BYD** has been selling fully electric and hybrid cars in China already for years. BYD is also investing significantly on the most expensive parts of NEVs, the batteries and infrastructure equipment. In 2014, it opened the world’s largest EV charging station in China (Massiero et al. 2016).
• **SAIC** has several pure and hybrid electric vehicles in its line-up already and is also partnered with the VW and GM brands in China.

• **FAW Group** is the oldest car manufacturer in China and one of the four big legacy manufacturers.

• **Geely** owns the Volvo brand which has committed to having only electric and hybrid cars starting in 2019. Geely itself has a fully electric car as well as plug-in electric hybrid vehicles in its line-up.

• **BAIC** has opened up an EV R&D centre in California and is the Chinese partner for Daimler and the companies are jointly investing USD 735 million on EVs in China.

• **Dongfeng**, formed in 2001, has aggressive plans globally and in EVs. It has set up a joint venture with the Renault-Nissan Alliance to sell electric cars in China.

In terms of best selling NEV models, BYD and BAIC are currently on the top in China (Figure 2).

![Figure 2. Top selling NEVs in China, 2016. Source: Frost & Sullivan (2017a).](image)

### 3.4 Monitoring system and evaluation of the initiative

There is no detailed information available about how the Chinese government monitors the progress, but it can be assessed the key numerical targets (e.g. number of sold/produced NEVs) are relatively easy to follow and they are monitored. Furthermore, many of the targets of NEV policy have been put forward in key documents of the Chinese economic and societal development, such as the National Middle to Long Term Plans for Science and Technology Development or the Five-Year Plans, and hence the target setting process as well as the monitoring is likely to be closely linked to the formulation and follow-up of such plans.

Moreover, over the years the course of the NEV policy has already been changed a few times, and it seems that the Chinese top-down governance model enables re-steering and altering the course of the initiative along its development. As an example of re-steering, the Chinese government has recently announced that subsidies for EVs would be reduced by 20% from 2017 onwards, which shows the intention to constantly adjust and improve its policies to achieve an optimised market response (IEA 2017).
3.5 Level and type of citizen engagement in the initiative

As mentioned above, NEVs initiative in China has been strongly government led and top-down driven. It seems that citizens are mainly seen and regarded as consumers and potential buyers of new energy vehicles. On the basis of the available information however it seems that overall NEVs policy has been quite widely communicated. For instance, many of the local and regional programmes have received attention in the press (Howells et al. 2015). Furthermore, some large-scale events in which NEVs have been promoted, such as the Beijing Olympic Games, have been subject to much attention.
4 Policy instruments and wider policy-mix used for implementing the initiative

Over the course of the NEV policy, a relatively comprehensive policy-mix has been mobilised to promote the development. The Chinese NEV policy has clearly included both supply and demand side measures. R&D policy and programmes have had an important role, but at the same time other policy sectors and related instruments have been central such as subsidies to consumers and car makers, trade policy, taxation, public procurement and regulation.

4.1 Description of the R&I policy instruments used for implementing of the initiative

The following R&I instruments have mobilised to support the NEV mission:

R&D projects supported under national S&T programmes

- **Electric Vehicle Major Project** as a part of the National High-Tech Research and Development Programme (the 863 Programme) under the 10th Five-Year Plan (2001-2005) (launched by MOST). RMB 2.4 billion (EUR 130 million) was invested in four key areas of technology (Figure 3). As a result, 796 patent applications were submitted, seven public inspection and test platforms were established, 26 national standards were issued and eight cities carried out demonstration operation of NEVs.

![Figure 3. The investment in NEVs R&D under the 10th Five-Year Plan. Source: Nieuwenhuis & Lin (2015)](image)

- **Energy-Saving and New Energy Vehicle Major Project** as a part of the 863 Programme during 11th Five-Year Plan (2006-2010). The Major Project included 270 projects with a total budget of RMB 11.1 billion (EUR 1.42 billion) and with the participation of 14 600 researchers from 432 NEV enterprises, research institutes and universities. Activities were targeted at five key areas (Figure 4) (Nieuwenhuis & Lin 2015). With the support of the projects, 350 EV models entered national auto announcement directory, 59 EV standards at national level or industrial level were formulated, 15 national key laboratories and engineering technology research centres and 48 EV research and development platforms were built, and 2011 patent applications were submitted.

---

4 The exact budget figures of R&D programmes vary to some extent depending on the source of information.
Electric Vehicle Key Technology and System Integration Major Project, as a part of the 863 Programme, during the period of 12th five-year plan (2010-2015). 77 subjects were funded by RMB 738 million (EUR 95 million).

Government support for commercialisation of electric vehicles and their components

New Energy Automobile Industry Technological Innovation Programme, launched in 2012 by Ministry of Finance, MIIT and MOST, focusing on BEV, PHEV and FCV and power battery. 25 key projects were supported.

4.2 Connections with other policies

In addition to R&I funding, at least the following policy instruments have also been used to support the NEV development and transition:

Subsidies for purchasing NEVs

Consumers who purchase EVs can get subsidies from the government. This has been in place at least since 2013 but most probably already earlier. It has been argued that currently China has the most generous purchase incentives globally aside from Norway (Cliver 2017; see also Wang et al. 2017). According to Herztke et al. (2017), China’s monetary subsidies amount on an average car to approximately 23% of the total EV price whereas in Norway the corresponding figure is 45%. In terms of subsidies, however, China has announced that after 2020 it will gradually move from direct subsidies towards nonmonetary subsidies (Herztke et al. 2017).

Regulation

Certain Chinese cities restrict licence plates from combustion engine cars. For instance, in Beijing licences for combustion engine cars are available only by lottery whereas in Shanghai they can cost up to RMB 80 000 (EUR 10 000) and be subjected to long waiting times (Cliver 2017). Other Chinese cities where such measures have been adopted include Guangzhou, Guiyang, Hangzhou, Shanghai, Shenzhen and Tianjin (see table 2 below for details).

According to Herztke et al. (2017), also Denmark would have higher overall monetary subsidy than China (49 per cent).
Table 2. Policies restricting availability of licence plates in China and waivers for NEVs

<table>
<thead>
<tr>
<th>Cities</th>
<th>Since</th>
<th>Details</th>
<th>Waiver for new energy vehicles</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>2010</td>
<td>Lottery</td>
<td>2013</td>
<td>Quota exists, but odds are better for new energy vehicles</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>2012</td>
<td>Lottery</td>
<td>2014</td>
<td>New energy vehicles allowed license plate</td>
</tr>
<tr>
<td>Guiyang</td>
<td>2011</td>
<td>Lottery</td>
<td>2015</td>
<td>New energy vehicles allowed license plate</td>
</tr>
<tr>
<td>Hangzhou</td>
<td>2014</td>
<td>Combined lottery and auction</td>
<td>2014</td>
<td>New energy vehicles allowed license plate</td>
</tr>
<tr>
<td>Shanghai</td>
<td>1994</td>
<td>Auction</td>
<td>2014</td>
<td>Quota on new energy vehicles allowed license plate</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>2014</td>
<td>Combined lottery and auction</td>
<td>2014</td>
<td>Quota exists, but odds are better for new energy vehicles</td>
</tr>
<tr>
<td>Tianjin</td>
<td>2013</td>
<td>Combined lottery and auction</td>
<td>2014</td>
<td>New energy vehicles allowed license plate</td>
</tr>
</tbody>
</table>

Source: IEA (2016)

- Quota scheme: car makers are charged for every traditional fuel car they produce (and credited for every electric or hybrid vehicle produced).

**Tax reduction and exemption**

- Purchasing BEVs, PHEVs and FCVs will be exempted from tax on vehicles and vessels. In 2017, exemptions from acquisition and excise taxes range between RMB 35 000 and RMB 60 000 (EUR 4 500 to EUR 7 700). Local and regional authorities can complement these within the limit of 50% of the central government subsidies (IEA 2017).

- NEVs are exempted from circulation/ownership taxes

**Public procurement**

- China’s NEV policy has relied strongly on government procurement of NEVs (Howells et al. 2015, 8). In 2014, the National Government Offices Administration announced a measure that electric cars make up at least 30% of government vehicle purchases by 2016. Central government ministries and agencies are expected to take the lead on purchases of BEVs, PHEVs and FCVs. The ratio will be raised beyond 2016, when local provinces are required to meet the target.

- Pilots and demonstrations have been carried out in various cities since 2001.

**Setting standards for electric vehicles**

- China has established a basically sound NEV standard system with 78 published NEV standards. Among them, 28 are the standard of the finished vehicle and general standards, 24 are standards of power battery and key assembly standards, 26 are standards of charging infrastructure standard. Yet, different NEV enterprises understand differently these standards, which resulted in incompatible products.

**Tax credit to car manufacturers**

- NEV enterprises are entitled to 15% rate of corporate income tax which is 10% lower than the normal
Reward / subsidies to charging infrastructure construction

- Cities or city clusters with the certain number of NEVs registered receive fiscal reward / subsidy from the central government for charging infrastructure construction

General trade policy

- Since 2006 and especially after the launch of ‘indigenous innovation’ as an overall innovation policy target in China, trade policy has played an increasing role in NEV development. Consequently, the Chinese government has restricted electric vehicle imports and demanded increasingly stringent technology transfer from foreign firms. These have in practice led to trade barriers and have prevented foreign technology from entering China (Howells et al. 2014, 14).

Table 3 below summarises some instruments used in China and selected other countries to support the uptake of NEVs. According to the table, the Chinese policy appears quite comprehensive but many other countries also have encompassing policies in this area. However, the table does not take into account e.g. the use of public procurement which has had an important role in China.

Table 3. Summary of certain NEV policies and instruments used to support EV uptake selected countries (in 2015).

<table>
<thead>
<tr>
<th>Country</th>
<th>EV purchase incentives</th>
<th>EV use and circulation incentives</th>
<th>Waivers on access restrictions</th>
<th>Tailpipe emissions standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reg. at registration tax</td>
<td>Sales tax exemptions (except Vat)</td>
<td>Tax credits</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Canada</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>China</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Denmark</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>France</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Germany</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>India</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Italy</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Japan</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Netherlands</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Norway</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Portugal</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>South Korea</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Spain</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>Sweden</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
<tr>
<td>United States</td>
<td>No policy</td>
<td>No exemptions</td>
<td>No exemptions</td>
<td>Access to bus lanes</td>
</tr>
</tbody>
</table>

Source: IEA (2016)

4.3 Key turning points of the initiative and policy adaptation measures

The following table summarises some of the most important changes that have taken place during the NEV and related policy adaptation measures.
<table>
<thead>
<tr>
<th>Major changes / turning points of the initiative</th>
<th>Description of the flexibility mechanism / policy adaptation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall policy change: “indigenous innovation” set as a core target of the national innovation strategy in 2006.</td>
<td>Strengthening of the NEV policy: NEV production and sales seen to play an increasingly prominent role in this China’s new strategy.</td>
</tr>
<tr>
<td>Slow progress towards the goals</td>
<td>Move towards rapid deployment in 2009: industrialisation of new energy vehicles and set-up of pilot cities to promote the use of NEVs in the public sector.</td>
</tr>
<tr>
<td>Goals not being achieved, initiative relying and depending too much on the public sector.</td>
<td>More stringent regulation measures being discussed in 2017 (potential ban of manufacturing and sale of cars with traditional fuel engines) and changes in subsidy systems.</td>
</tr>
</tbody>
</table>
5 Realised or expected outputs, outcomes and impacts

5.1 Outputs and new instruments

At least the following outputs can be identified:

- Hundreds of research and development projects (e.g. 270 projects under the Energy-Saving and New Energy Vehicle Major Project, 2006-2010, and 77 projects under the Electric Vehicle Key Technology and System Integration Major Project, 2010-2015)
- NEV R&D platforms (at least 48) and public inspection and test platforms (at least 7)
- National standards (at least around 80)
- 15 key national laboratories and engineering technology research centres built
- Demonstration operations and projects (large number of cities)
- Thousands of patent applications (at least around 3000)

5.2 Outcomes

Over the course of the NEV policy, the national capacity and technological knowhow in the NEV area has substantially developed in China. A clear indication of this is that following the NEVs policy, hundreds (at least 350) of NEV models have entered Chinese national auto announcement directory. For instance, in 2016, 25 new NEV models were introduced to the Chinese market and currently there are in the market around 75 different NEV models which is more than any other country included in McKinsey’s Electric Vehicle Index (Herztke et al. 2017).

Furthermore, China hosts two the top fine lithium battery makers in the world (CATL and BYD) and many Chinese companies have an edge in patents in battery-powered technology (Cliver 2017). Following the NEV policy, Chinese car manufacturers have increasingly started to invest in R&D. For instance, Dongfeng and BYD invested in EV R&D centres already during the 10th Five-Year Plan (2001-2005).

In more concrete terms, the following dimensions of NEV technology have been mentioned as areas where China has made significant progress (OECD 2014):

- PHEV (plug-in hybrid vehicles) technology made significant progress. Some PHEV models are close to international advanced level.
- BEV (battery electric vehicles) technology is increasingly matured and ready to commercialise. Some Chinese automakers have mastered the core technologies in vehicle powertrain matching and integration, and vehicle control. They have capability to develop BEVs close to international advanced level.
- Significant progress has been made in FCV (fuel-cell vehicle) technology. So far, China has preliminarily grasped core technologies in finished vehicle, power system and key components; built up BEV powertrain technology platform with own intellectual property rights; formed a complementary research system of key components, including the fuel cell engine, power batteries, DC/DC converter, drive motor, hydrogen storage and supply.
• Progress has been made in key components. In terms of power battery, Chinese automakers have preliminarily had product research and development capabilities and production equipment design and manufacturing capabilities. Power battery performance has gradually reached international advanced level. There is Chinese production in lithium ion battery anode materials and electrolyte. In terms of drive motor system, the main technical indicators have reached international level. In electric control system, China has initially formed small batch production ability of hybrid system and pure electric drive system.

5.3 Impacts

It is quite evident that to date China has not reached its mission targets in terms NEV penetration and transformative change, and according to current estimates will not reach the current numeric goals by 2020 and 2025. However, the NEV market has grown significantly and China has recently become the largest NEV market in the world. In terms of economic impact, it is also worth to note that a majority of NEVs sold in China are Chinese models, hence adding to domestic economic impact. The recent strong progress in China is also reflected in international comparisons, such as the McKinsey Electric Vehicle Index where China has made significant improvement from 2014 to 2016, in particular in indicators related to NEV industry (Figure 5 below).

Overall, however, one also needs to remember that the primary driver for NEV development in China was technological and economic upgrading and at least to some extent that has taken place. Ultimately the degree to which China will be able to achieve its vision of becoming global economic power through the NEV development remains to be seen.

Yet, NEV is about a large-scale systemic transition which by definition requires a substantial amount of time. Over time, the Chinese NEV policy has been confronted with a number of challenges which have been discussed in previous sections (such as backwardness of the domestic car industry, over-optimism of the Chinese government, high costs of the NEVs for consumers mainly due to batteries and reflected in the low enthusiasm of consumers as well as trade barriers and the prioritised role of large state-owned companies as targets of public R&D funding in the neglect of small, young firms).

Overall, the numbers of sold NEVs in China have been relatively low compared to the targets (Howells et al. 2014). For instance, the target of 500 000 NEVs by 2015 was not reached (OECD 2014, 14); in 2014, China produced 78 499 EVs and sold 74 763 EVs which was up 9.4 times and 9.2 times over the period of 2011 respectively. However, in recent years the pace of growth has accelerated: in 2016 around 330 000 - 350 0006 NEVs were sold in China and it was by far the largest electric car market in the world. The sales figures in China were more than double the number in the United States (IEA 2017; Frost & Sullivan 2017a; see Figures 6 and 7). Furthermore, the growth of Chinese NEV market in 2016 (85%) was considerably higher than in the US, Europe or anywhere else (Figure 8). Massive governmental subsidies and non-monetary incentives (e.g. exemptions from various types of restrictions of car use) have been seen as major factors behind this latest surge (cf. Chapter 4 above; Wang et al. 2017). Yet, despite the recent progress, electric

6 The number of sold NEVs in China varies to some extent depending on the source of information (cf. e.g IEA 2017; Frost & Sullivan 2017a).
vehicles still have only 1.5% market share in China, while in Norway—which has globally the highest market penetration—the market share is around 29% (IEA 2017).

Figure 5. McKinsey Electric Vehicle Index, 2016. Overall score, for selected countries.⁷

Figure 6. Electric car sales, market share, and BEV and PHEV sales shares in selected countries, 2010-16.


⁷ In the McKinsey Electric Vehicle Index the supply indicators address the industry side, i.e. OEMs (Original Equipment Manufacturer) and suppliers within each country and they cover factors such as current and projected EV production and the manufacture of key components, including e-motors and batteries. Demand indicators assess EV share of the country’s market and go beyond merely accounting for the number of vehicles sold. Among other things, elements such as incentives (including governmental subsidies), existing infrastructure, and the number of EV models offered in various vehicle segments within each indexed country are measured.
According to the current estimates, in 2017 number of sold NEVs will rise to around 410,000 NEVs in China which would correspond to over 40% of global sales. It has been estimated that by 2025, 4.2 million NEVs would have been sold in China (Figure 9).
While the public sector has deployed significant numbers of public EVs in China – such as taxis, police cars, sanitation vehicles and buses – overall it has also missed its targets. In order to support local automakers and comply with central government directions, a few municipalities seem to have genuinely committed to electrifying a sizable portion of their fleet (Howells et al. 2014).

As with electric vehicles more generally, also in China infrastructure development has been key challenge that has hindered the development and the realisation of more profound impacts. In 2014, it was concluded that there were very few usable, public charging stations in China (Howells et al. 2014). Indeed, China’s share of publicly available slow chargers is smaller than its share of the global electric car stock. On the other hand, China covers a very large share of world’s publicly available fast chargers (Figure 10). Furthermore, according to the current plans, China aims to build 842 rapid-charging stations on expressways in the next two years (Frost & Sullivan 2017a).

The environmental impacts of China’s New Energy Vehicle policy are debatable. With respect to environmental and climate impacts of electric vehicle transition, the carbon intensity of electricity grids is of great significance. In China, where almost 90% of power derives from fossil fuels (and 70% from coal), the carbon intensity of grids is very high. Hence, it is somewhat unclear what the impact of the proliferation of electric cars in China is and will be on CO2 emissions. It has been argued that the prediction of NEVs in terms of reducing CO2 emissions is not very positive and that reducing CO2 emissions could only take place if coal combustion technologies improve and the share of non-fossil electricity increases significantly in the country (Huo et al. 2010). In a similar vein, another study (Lang et al. 2013) concluded that in the period of 2010-2020 NEVs can reduce energy consumption of vehicles by national average ratios of 17% - 33% and bring significant reductions of emissions but the electricity sources have significant influence on the actual outcomes. In scenario work by Li et al. (2016), it was argued that by 2030 deployment of NEVs will essentially shift the use of gasoline to coal-fired power generation in China and hence lead to more coal consumption and CO2 emissions of the power system. However, the impact of EVs in terms of CO2 emissions at the national level will largely depend on adopted the charging strategy (controlled vs. uncontrolled charging) (Li et al. 2016).

Furthermore, some analysts have argued that electric vehicles charged in China actually produce more particulate matter and chemicals that contribute to smog versus gas-engine cars (Spring 2017). A recent study by researchers at Tsinghua University argues that energy consumption and greenhouse gas emissions of a battery electric vehicle production
in China are about 50% higher than those of an internal combustion engine vehicle (Qiao et al. 2017). In some other countries, like Norway, carbon intensity of electricity grids may be very low and in those cases environmental impacts of electric vehicles are likely to be more clearly positive (Barkenhuis 2017).

5.4 Summary of the key indicators

<table>
<thead>
<tr>
<th>Key indicators</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timeline:</strong> 2001-2020 / 2025</td>
<td></td>
</tr>
<tr>
<td><strong>Objective and targets:</strong> The current objective of China's New Energy Vehicle policy is to have five million NEVs (i.e. cars that are either partially or fully electric) on the roads by 2020 and that by 2025 at least one in every five cars sold in China is a new energy model.</td>
<td></td>
</tr>
<tr>
<td><strong>Total budget:</strong> Not available, but the scale is supposedly (hundreds of) billions of euros.</td>
<td></td>
</tr>
<tr>
<td><strong>Annual budget:</strong> Not available</td>
<td></td>
</tr>
<tr>
<td><strong>Share of budget, public funding:</strong> Close to 100%</td>
<td></td>
</tr>
<tr>
<td><strong>Share of budget, private investment:</strong> Close to 0%</td>
<td></td>
</tr>
<tr>
<td><strong>Leverage effect (additional public/private investments the initiative has triggered):</strong> The initiative has triggered both additional investments at regional level as many local and provincial governments have become important advocates and stakeholders in the NEV development and supporting its development. Similarly, car manufacturers have started investing increasingly in NEV development and related R&amp;D.</td>
<td></td>
</tr>
<tr>
<td><strong>Key (official/public) indicators applied for monitoring the progress towards the targets:</strong> No detailed information available about how the Chinese government officially monitors the progress, but it can be assumed that at least the key numerical targets (e.g. number of sold/produced NEVs) are monitored.</td>
<td></td>
</tr>
<tr>
<td><strong>Other key indicators (e.g. outputs/outcomes/impacts):</strong> Output/outcome indicators such as research projects, standards, new research centres, demonstration projects, patents. Impact indicators more difficult to discern but they should be linked to the degree of penetration of NEVs. Environmental impacts particularly difficult to assess.</td>
<td></td>
</tr>
</tbody>
</table>
6 Conclusions and lessons learned

6.1 Identification and assessment of key strengths and weaknesses of the initiative

Table 4. Strengths and weaknesses of China’s NEV mission

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Strongly top-down driven initiative with large resources</td>
<td>• Backwardness of Chinese car industry (at the beginning of the initiative but also along the way), lacking design, engineering, assembly and quality control to produce viable NEVs.</td>
</tr>
<tr>
<td>• A comprehensive policy mix deployed to implement it.</td>
<td>• Limited connections to foreign technology development. Trade barriers largely preventing foreign companies to share with or transfer their technological expertise to Chinese firms.</td>
</tr>
<tr>
<td>• Persistent and long-term policy approach (undoubtedly needed in the case of systemic or transformative missions)</td>
<td>• Lack of enthusiasm from consumers to buy NEVs and carmakers to produce NEVs.</td>
</tr>
<tr>
<td>• Has induced change in e.g. companies’ behaviour (e.g. increased R&amp;D investments in NEV technology) and significant amount of outputs and outcomes, larger impacts still to be fully realised, but are potential</td>
<td>• Inadequate intellectual property protection</td>
</tr>
</tbody>
</table>

6.2 Lessons learned and key messages for European R&I policy

Transformative mission such as New Energy Vehicles implies a large-scale systemic change and hence necessitates a comprehensive policy mix. China’s NEV mission has been implemented through a policy framework covering both supply-side polices and demand-side polices which is crucial at an early stage of such transition. In principle, supply-side policies incentivise car manufacturers to develop, produce and improve NEVs and demand-side policies create demand for the NEVs and facilitate public sector and consumers to buy NEVs. Overall, the Chinese policy-mix appears diverse and complementary and at least on the basis of this analysis it is difficult to see clear lacks in the adopted policy.

Yet, as mentioned above, there have been substantial challenges in the Chinese NEV mission and the mission targets have not been reached (even though it seems that the pace of progress has been increasing in the very recent times). One clear pitfall in the China’s NEV case – which also may provide an important lesson for future mission other contexts – has been the fact that on the outset there needs to be a realistic assessment of the industrial capacity in the country or region with respect to the core technologies of the mission. In the Chinese NEV case, it appeared that the government’s original assessment of the domestic car manufacturers’ competences was too optimistic. This led to unrealistic goals and slow progress compared to set targets as building up the needed competences necessitates substantial amounts of time.

Another, and related, lesson from the Chinese NEVs experience is that such systemic missions require persistent policies and strategies: progress almost inevitably takes much time and the government needs to be persistent with the mission if it is to keep up with it.
This is not to say that changes should not be made along the way. On the contrary, as in the Chinese NEV policy, progress need to be monitored and re-assessments can and need to be done if considered necessary.

An important aspect of systemic or transformative missions such NEVs is the fact that they may easily comprise several, and in some cases, even contradictory objectives. In the Chinese NEVs case there have been multiple drivers or societal targets (economic and technological upgrading, CO2 emission and pollution reduction, energy security). Some of such targets may be very complex and extremely difficult to measure. In the Chinese NEVs case, the impacts on CO2 emissions and local pollution are very far from straightforward and it may even be that achieving the overall mission (large-scale penetration of NEVs) may lead to opposite (negative) impacts on some of the target categories (in this case increase in pollution and CO2 emissions). Such complexities in terms of targets and potential outcomes are important to take into account when planning and launching such large-scale missions.

In China’s NEV development thus far the government has played a crucial role in supporting NEVs, but there are concerns over the balance between the roles of the public and private sectors. There is a risk that car manufacturers rely too much on governmental subsidies in NEV production. Hence, ensuring a balanced participation between the public and private actors is of high importance in such missions. At the same time, large-scale system transitions like NEVs highlight the importance of cross-sectoral coordination at the level of government and wide-range of other actors which needs to be taken in to account and properly organised.
References


Getting in touch with the EU

IN PERSON
All over the European Union there are hundreds of Europe Direct Information Centres. You can find the address of the centre nearest you at: http://europa.eu/contact

ON THE PHONE OR BY E-MAIL
Europe Direct is a service that answers your questions about the European Union. You can contact this service
– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
– at the following standard number: +32 22999696 or
– by electronic mail via: http://europa.eu/contact

Finding information about the EU

ONLINE
Information about the European Union in all the official languages of the EU is available on the Europa website at:
http://europa.eu

EU PUBLICATIONS
You can download or order free and priced EU publications from EU Bookshop at:
http://bookshop.europa.eu. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see http://europa.eu/contact)

EU LAW AND RELATED DOCUMENTS
For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

OPEN DATA FROM THE EU
The EU Open Data Portal (http://data.europa.eu/euodp/en/data) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.
The New Energy Vehicles (NEV) policy in China is an example of a large scale systemic and transformative mission. It has been an attempt by the Chinese government to address several challenges that the country has been facing at the same: energy security, pollution and environmental challenges, and economic and technological upgrading. It has been implemented in a strongly top-down manner with a relatively comprehensive policy mix covering both supply-side policies and demand-side policies. While considerable progress has been achieved, the overall mission targets of the policy have not yet been met. Yet, China has recently become the largest NEV market in the world. Challenges of the policy have been related to the general backwardness of Chinese car industry, limited connections to foreign technology development and lack of enthusiasm from consumers to buy NEVs and carmakers to produce NEVs. The Chinese NEV case also highlights the complexity and potential contradictions that the objectives of such large-scale missions may entail. In the NEV case, two of the original objectives may in practice be conflicting: achieving the overall mission (large-scale penetration of NEVs) may lead to opposite (negative) impacts in terms of environmental objectives (i.e. lead to increase in pollution and CO2 emissions).

*Studies and reports*