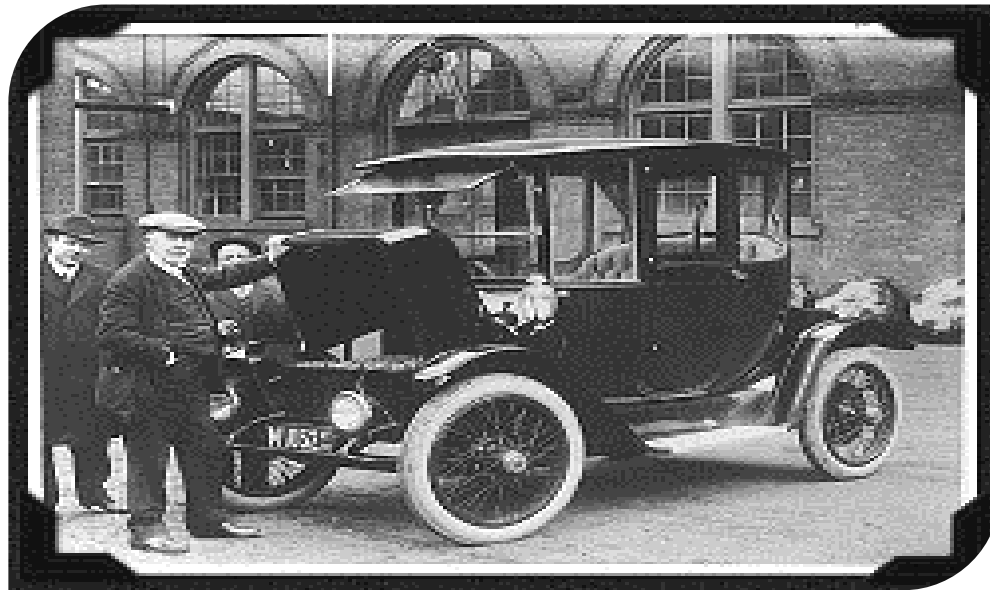


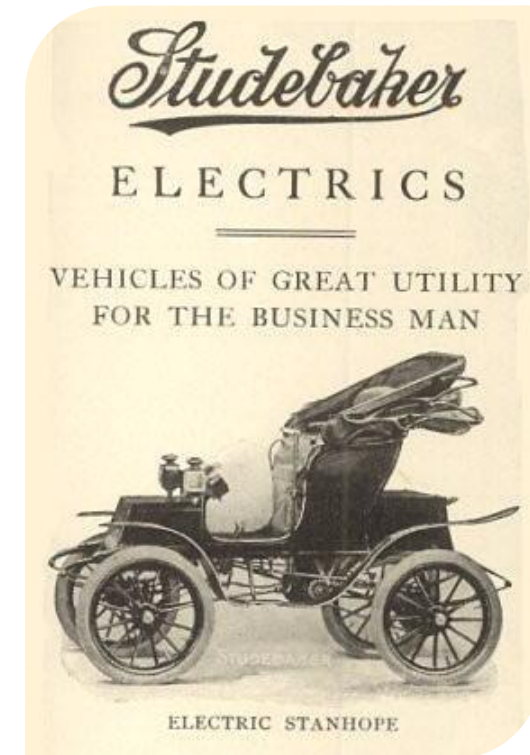
# Electric vehicles and battery technology

Sanjiv Tumkur, Head of Equity Research

# Electric cars have been around for a long time



Thomas Edison with his 1913 Baker Electric Automobile



1908 Studebaker Electric

# Initially displaced by the success of the Ford Model T



# Electric cars have evolved

Toyota Prius



Tesla Model S



Nissan Leaf



REVAi G-Wiz

# Advantages of electric cars

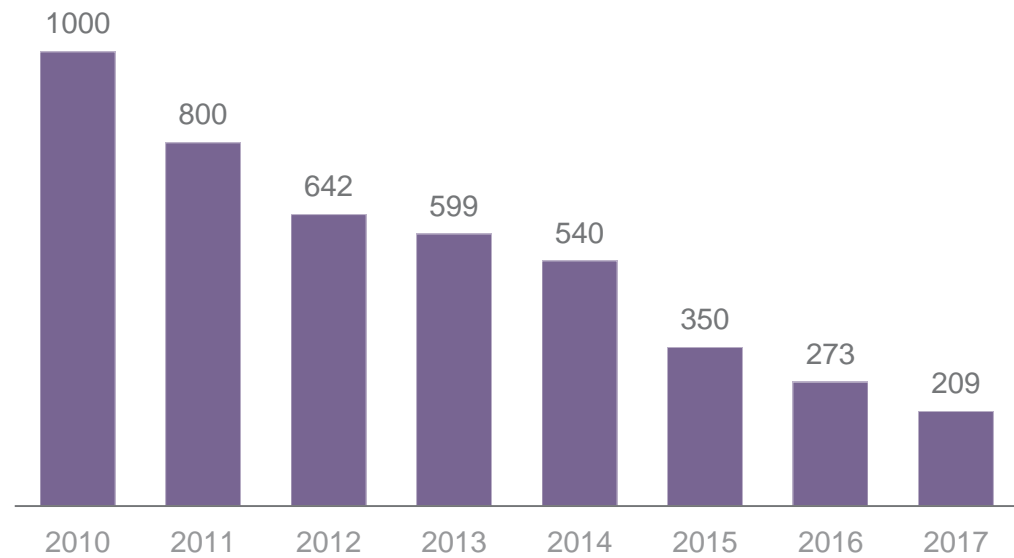
- lack of exhaust emissions
- energy efficiency
- lower running costs (1) – energy  
(2) – maintenance
- instant power and torque

# The battery revolution



Rechargeable lithium-ion batteries

*Average EV lithium-ion battery prices (\$/kWh) 2010-17*



Source: Bloomberg New Energy Finance annual battery price survey. Price is an average of Battery EV and Plug-In Hybrid EV batteries, including both cell and battery pack costs.

# Barriers to adoption of electric cars

- style and range of options
- range anxiety (charging speed and availability of infrastructure)
- upfront cost (battery vs internal combustion engine/drivetrain)
- power (size vs energy density)
- battery life/degradation

# The Gigafactory



Photo: Tesla Motors. Tesla Gigafactory in Sparks, Nevada – started mass production in January 2017 across 4.9m square feet of space.



# The auto industry is shifting

Ford Focus Electric



BMW i3S



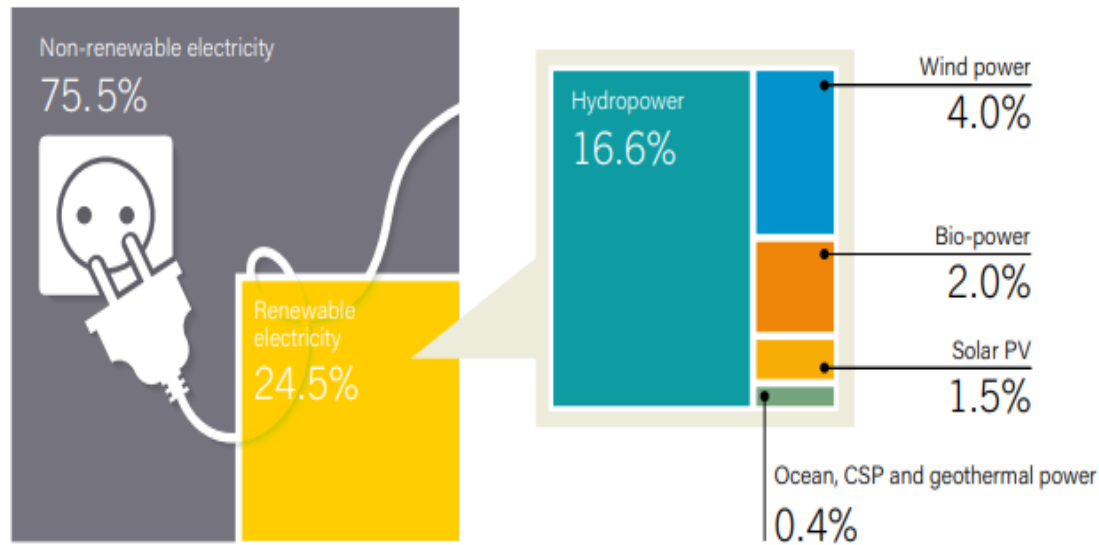
Mercedes EQ Concept+



Volkswagen E-Bugster

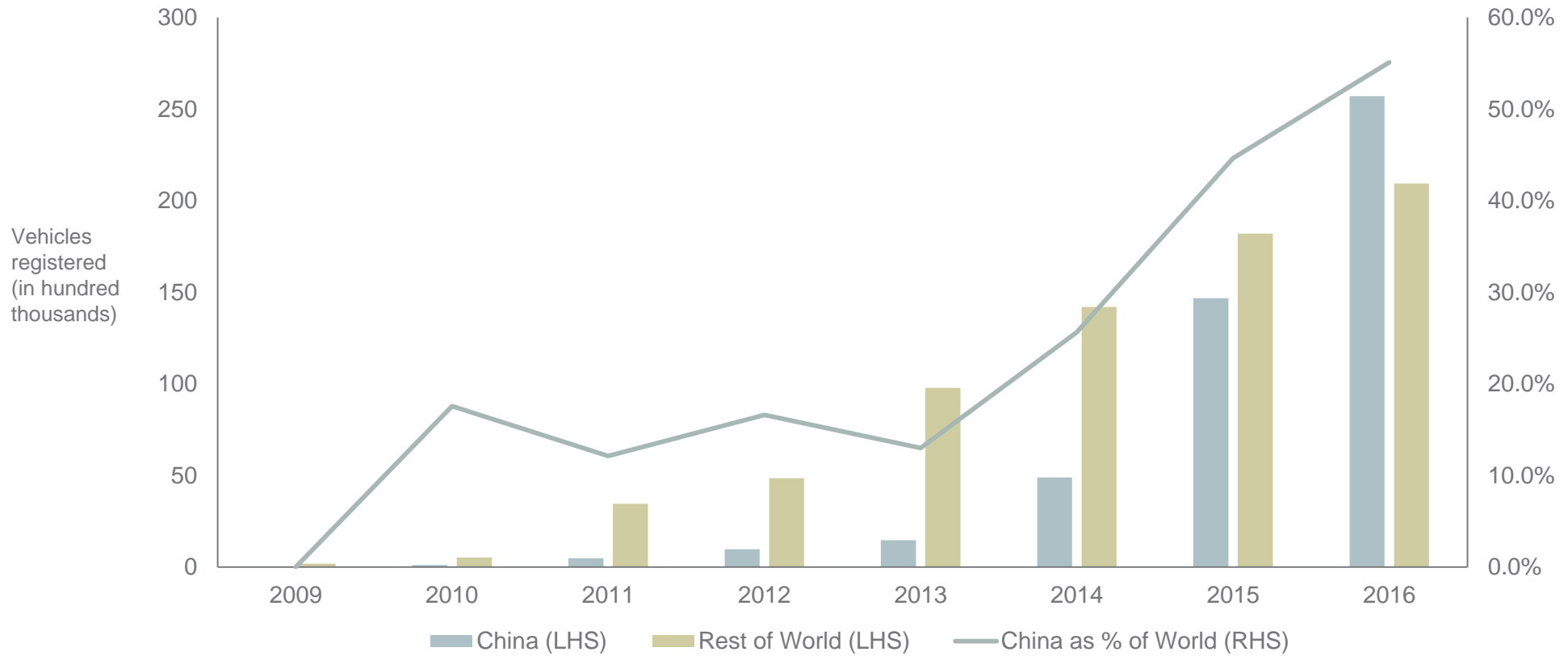
# Alternative energy

**Figure 4.** Estimated Renewable Energy Share of Global Electricity Production, End-2016



# China and electric vehicles

*Battery electric vehicle registrations – China versus the rest of the world*



Source: Global EV Outlook 2017 - Two million and counting - Clean Energy Ministerial, International Energy Agency

# Implications of new energy



# Implications for sectors



# Important information

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