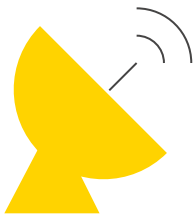


# The digital and technological revolution in electric mobility

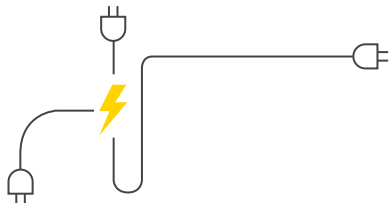


## Communications and sensors

**For example:** TomTom; Siemens; ChargePoint; Qilu Transportation

**Enables:** Charge point route planning; IoT based communication; vehicle-to-infrastructure and vehicle-to-vehicle communication; traffic flow management; mobile communication; battery swapping information; software upgrades

**Business case:** Improved car safety; new mobility/communication based business models; reduced range anxiety



## Smart grid

**For example:** ABB; UPS

**Enables:** Grid optimized charging; grid stabilization

**Business case:** Lower charging cost; grid balancing services from EVs; higher concentration of charging points



## Autonomous driving

**For example:** Tesla; General Motors; Mahindra & Mahindra

**Enables:** Vehicle can self drive to charge points; optimized battery efficiency and lifetime; high usage of vehicle

**Business case:** User convenience; lower fuel/operating costs; lower repair/maintenance costs; reduced auto accidents; improved car safety



## Blockchain

**For example:** eMotorWerks; Share & Charge; Xain

**Enables:** Efficient and secure vehicle charging and billing system; better integration into distributed energy generation networks; integration of charging economy with other market places (for example)

**Business case:** Peer-to-peer charging business models; tokenized charging infrastructure investment; incentivizing sharing of home charging stations; databased business models (for example)

## New charging technologies

**For example:** Qualcomm; Plugless; Ubitricity

**Enables:** Intelligent wireless charging, including inductive charging; faster charging

**Business case:** Convenient, everywhere charging (e.g. on a parking spot); car-to-car charging

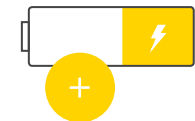


## New battery technologies

**For example:** Panasonic; Fisker; Ionic Materials; solid-state batteries (and more)

**Enables:** Lower weight; higher power density; faster charging; inductive charging; faster charging

**Business case:** Lower vehicle costs; longer range; better charging and driving performance

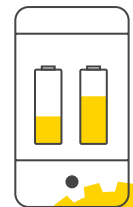


## Battery management system (BMS)

**For example:** BYD; LG Chem; Maxim; Texas Instruments

**Enables:** Monitoring and control of voltage, current, state of charge for battery health and performance

**Business case:** Longer battery life; higher operational efficiency; lower manufacturing cost

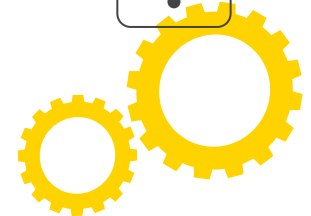


## Additive manufacturing

**For example:** NRC; Porsche Engineering; UTRC; XEV

**Enables:** Use of cheaper more abundant materials; better designs and performance of motors; vehicle weight reduction

**Business case:** Lower vehicle cost; Less fuel usage



## Nanotechnology

**For example:** Gold nanowire, graphene, and carbon nanotube batteries (all at the research level)

**Enables:** Faster battery charging; longer battery life; longer range

**Business case:** User convenience

