

IoT for Smart Transportation Systems

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Climate change needs to be mitigated

2016 hottest year ever recorded - and scientists say human activity to blame

- Final data confirms record-breaking temperatures for third year in a row
- Earth has not been this warm for 115,000 years

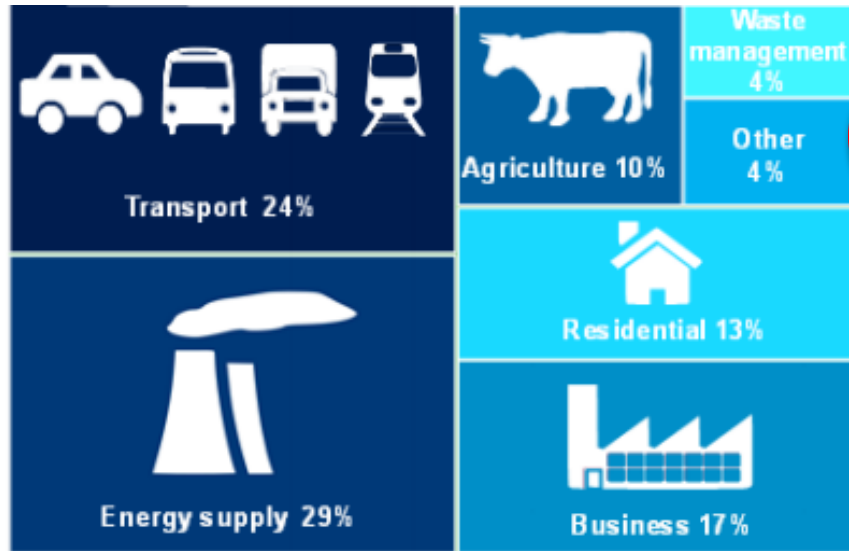


The natural El Niño climate phenomenon helped ramp up temperatures to “shocking” levels in early 2016.
Photograph: P B Verma/Barcroft Images

2100?



Transportation is a major contributor of greenhouse emissions



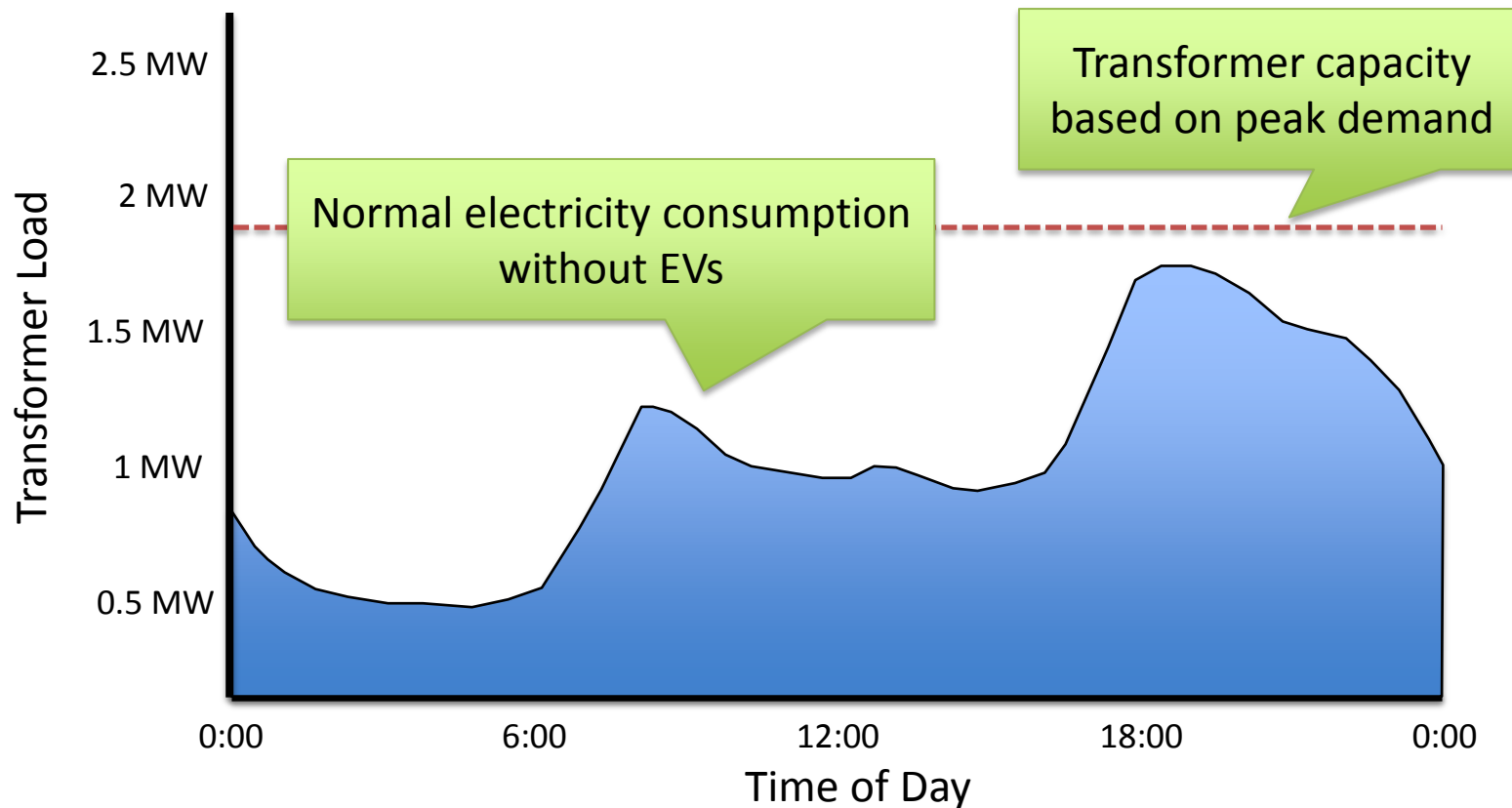
- Electric vehicles



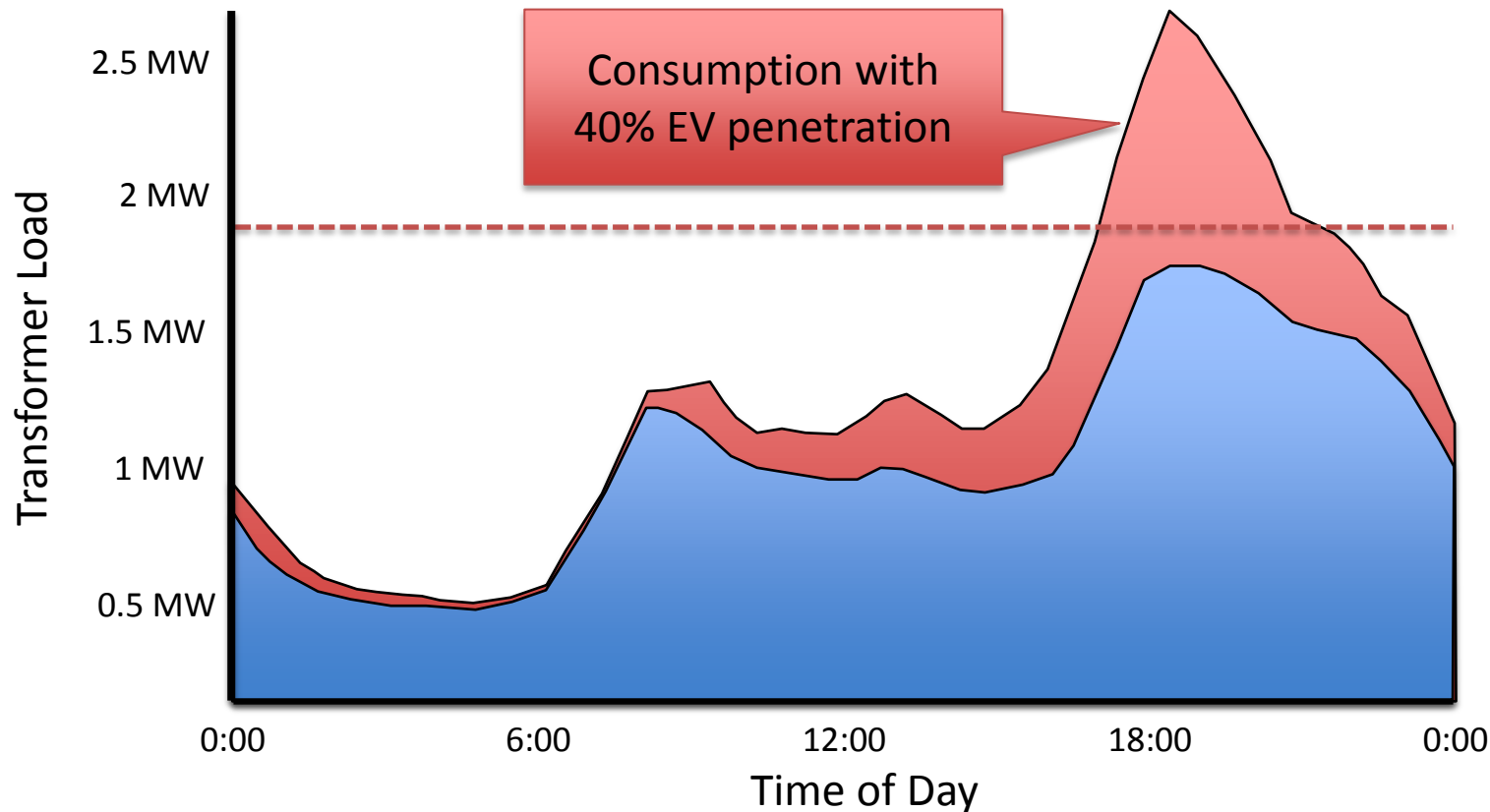
- New ownership models



Uncontrolled EV charging will cause considerable strains on grid



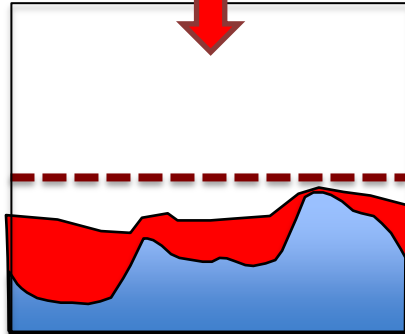
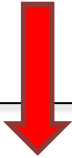
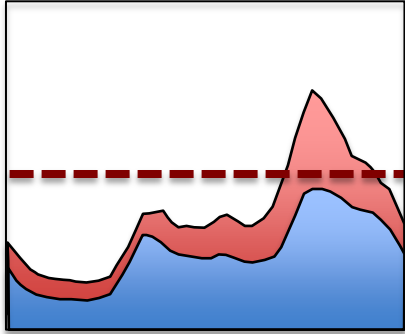
Uncontrolled EV charging will cause considerable strains on grid



We need to balance loads better

Charge electric cars smartly to take pressure off national grid - minister

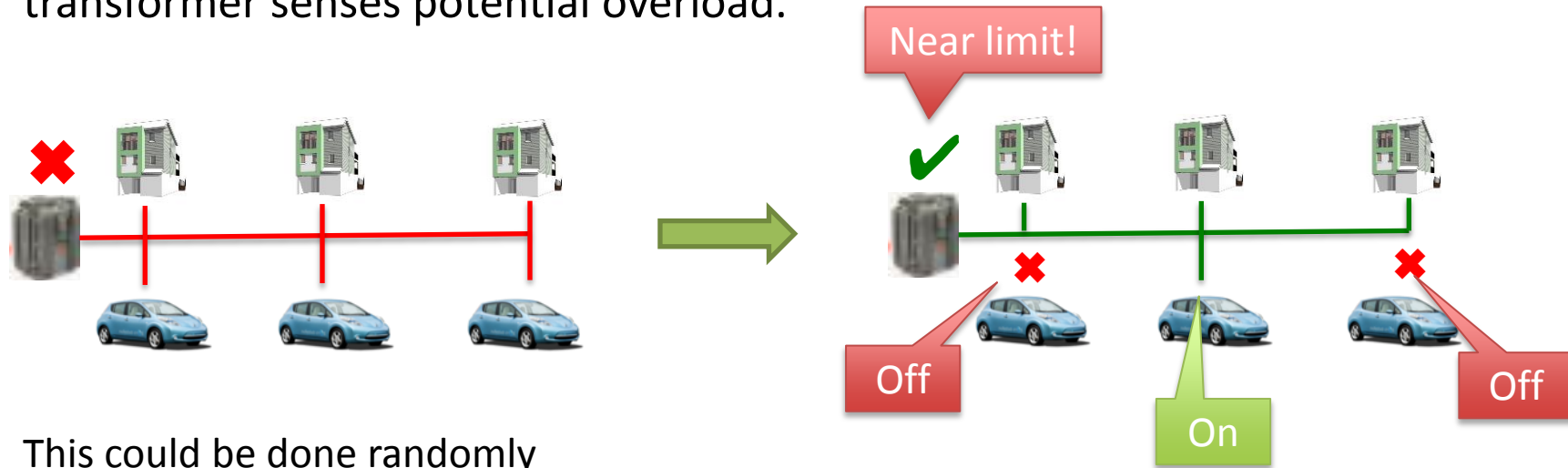
SSE trials 'demand-side response' where vehicles start charging a few hours after being plugged in, when demand is lower



An electric car is charged on a London street. Photograph: Miles Willis/Getty Images for Go Ultra Low

IoT-based Smart Charging

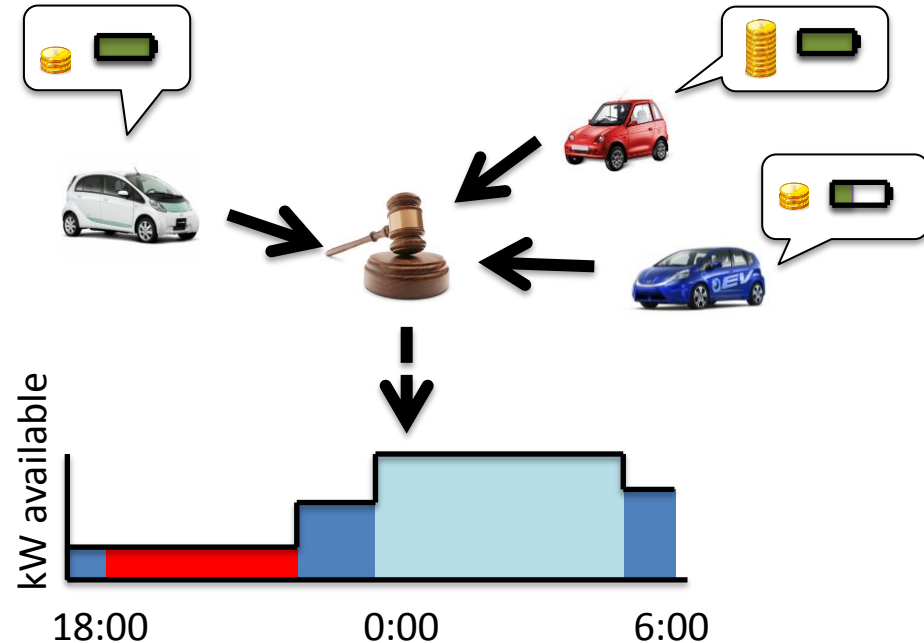
- Charging points are *connected* and switched off automatically when local transformer senses potential overload.



- This could be done randomly
- But: not based on drivers' requirements for charging, so can be very inefficient
 - Example: Everyone charges just too little for their journeys the next day

Intelligent Incentive-Aware Smart Charging

- EV drivers **bid for electricity** when they plug in their vehicle (using an interface on their IoT-equipped chargepoint or a mobile app)
The bid includes both *requirements* (e.g., charging deadline and amount of energy needed by deadline) and maximum *willingness to pay*
- Charging is **coordinated centrally**, taking into account all drivers' constraints and their bids / valuations
- Payments are carefully designed using **game theory** to prevent strategic bidding. In particular, drivers have no incentive to:
 - overstate their requirements
 - understate their willingness to pay



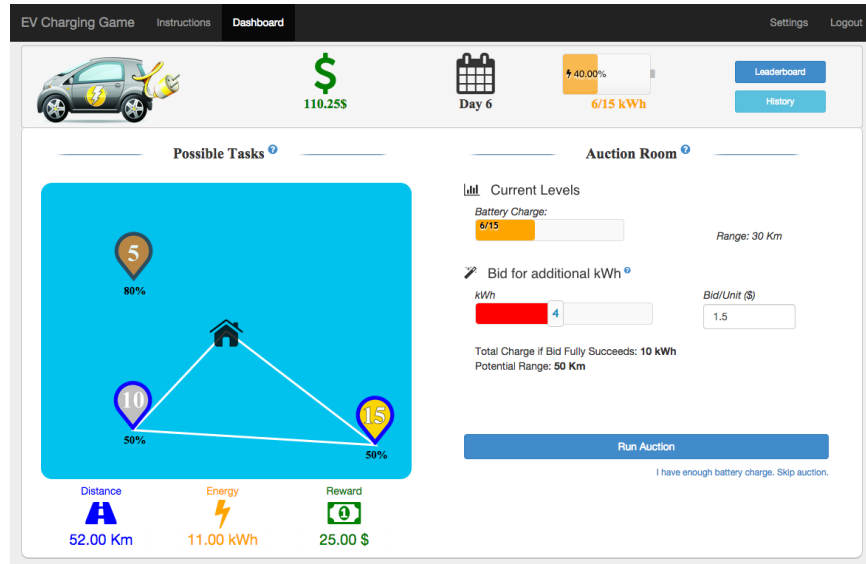
Intelligent Incentive-Aware Smart Charging

- Benefits:
 - Charging is coordinated in real time, based on current transformer load
 - More flexible drivers are automatically deferred to less congested times
 - Drivers that urgently need electricity are prioritised
 - But may end up paying more if competition is high
 - Bidding can be delegated to intelligent software agents that learn a driver's travel patterns and willingness to pay
 - Experiments show we can sustain up to 40% more electric vehicles within a given set-up.
- But many challenges remain...

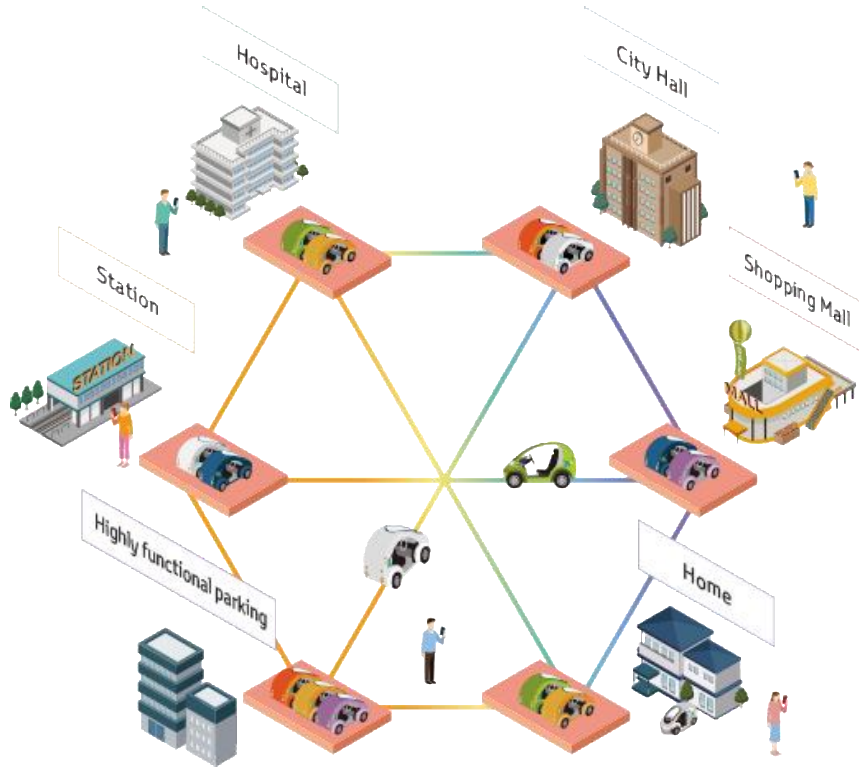


Open Challenges

- Expense of real-world trials



Carsharing



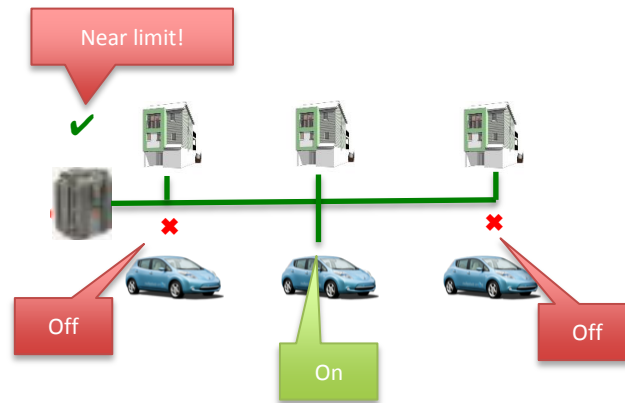
TOYOTA



- We use adaptive incentives to balance availability in real time within a carsharing system.

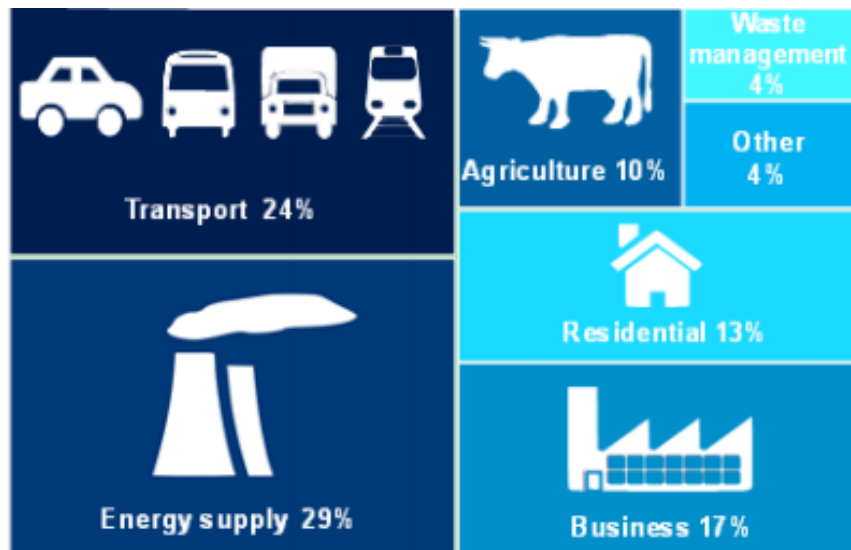
Conclusions

- IoT technologies enable **smart EV charging schemes**.



- Their full potential is achieved using **intelligent** and **incentive-aware** algorithms

Trends



	2014-2015 % change
Energy supply	↓ 12%
Waste management	↓ 7%
Business	↓ 3%
Other	↓ 1%
Agriculture	↔ 0%
LULUCF	↑ 1%
Transport	↑ 2%
Residential	↑ 4%