

Emerging best practices for electric vehicle charging infrastructure

Dale Hall, Nic Lutsey

*9 October 2017
EVS30, Stuttgart, Germany*

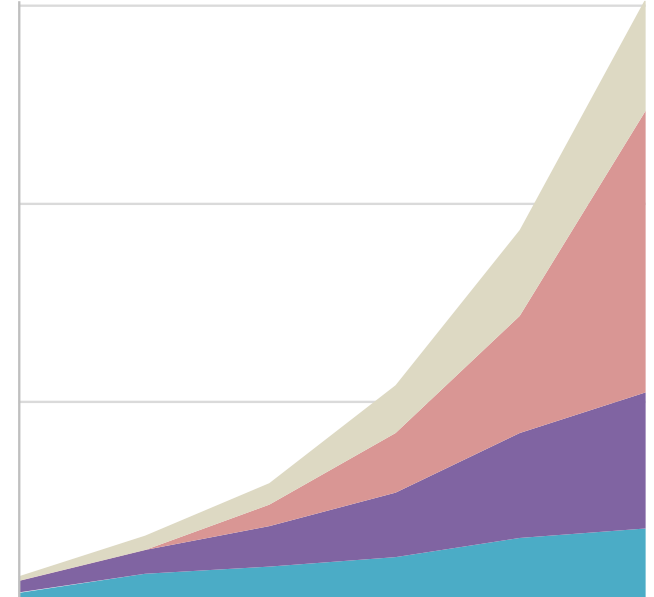
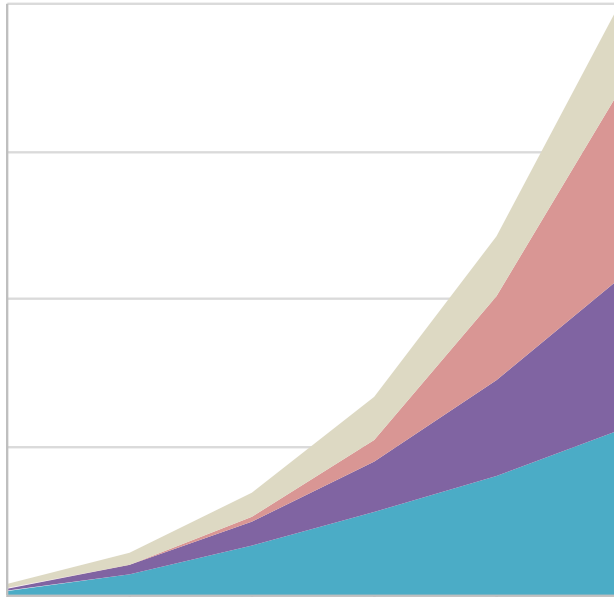


Project scope

- Research questions:
 - How does public charging availability differ across top global EV markets?
 - Are benchmarks emerging for public charge points per EV?
 - Are clear trends emerging for percent public charging that is DC fast?
 - Is public charging statistically linked with electric vehicle uptake?
- Scope for analysis:
 - Austria, Belgium, Canada, China, Denmark, Finland, Germany, Japan, Netherlands, Norway, Sweden, Switzerland, U.S., U.K. (90% of EV sales)
 - Analysis at metropolitan area level (for areas over 200,000 population)
 - Analysis of data at end of 2016

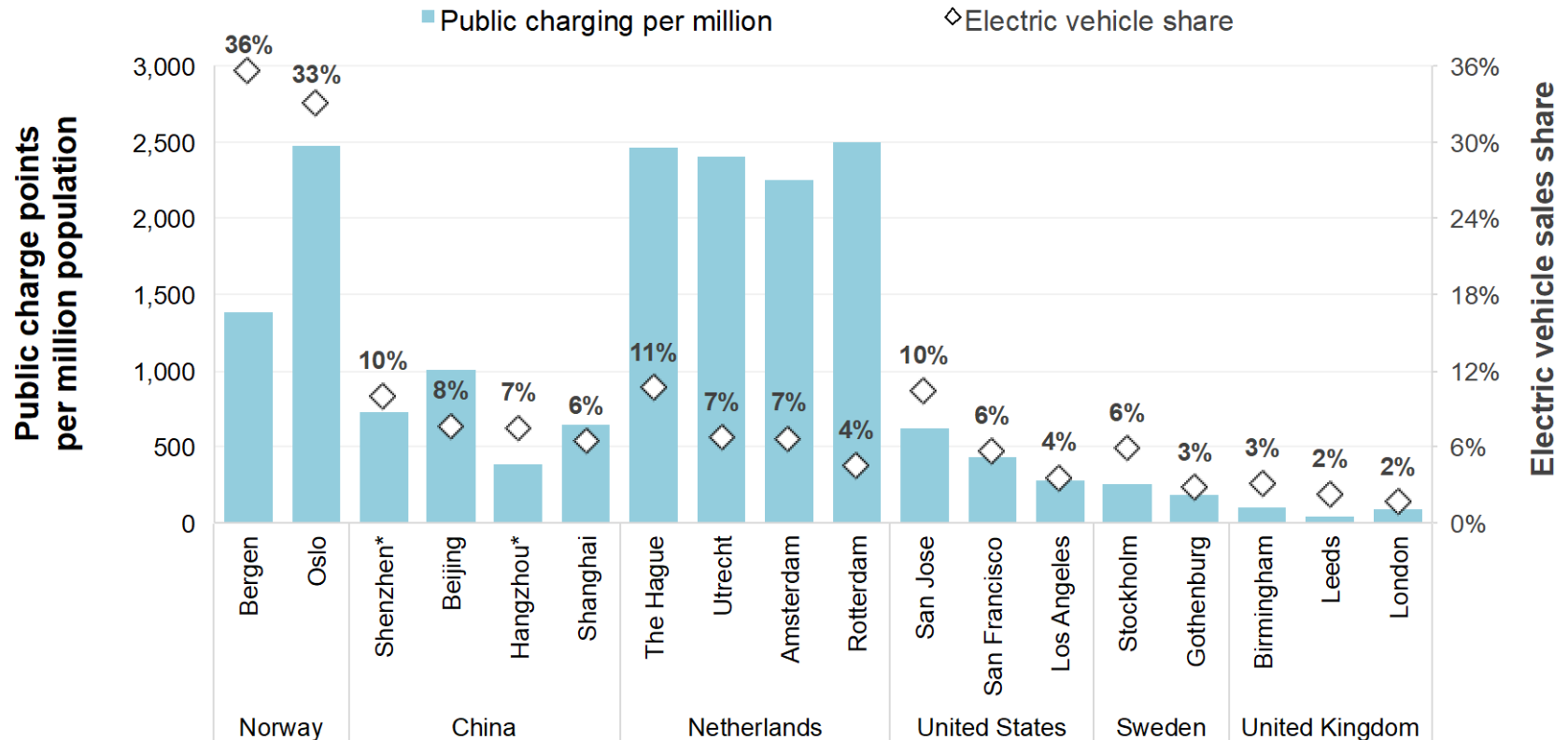
Electric vehicles and public charging have grown together

- At end of 2016: About 2 million electric cars and 300,000 public charge points



How much public charging is there in top EV markets?

- Public charging generally increases with EV share (*but it's complicated...*)
- Norway/Netherlands have >10x, China/California have 3-5x average charging availability



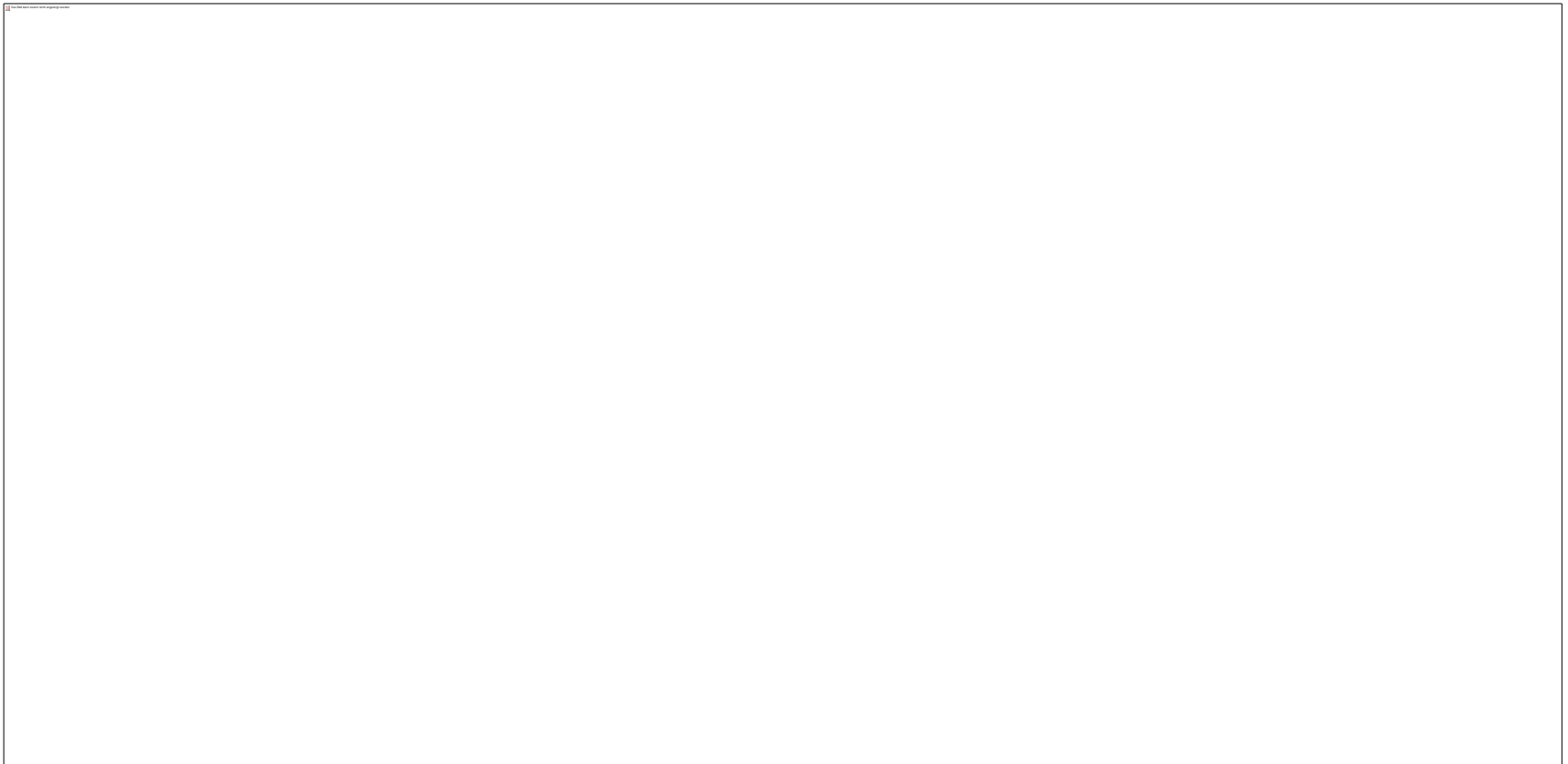
How many EVs are there per public charge point?

- To estimate future charging infrastructure needs, other research and government goals suggest a wide range of ratios for EVs per public charging point

Region	Electric vehicle per public charge point ratio	Source
European Union	10	European Parliament (2014)
China	8 (pilot cities) 15 (other cities)	NDRC (2015)
Global	8-15	EVI (2016, 2017)
United States	7-14	EPRI (2014)
United States	24	NREL (Wood et al., 2017)
California	27	CEC & NREL (2017)

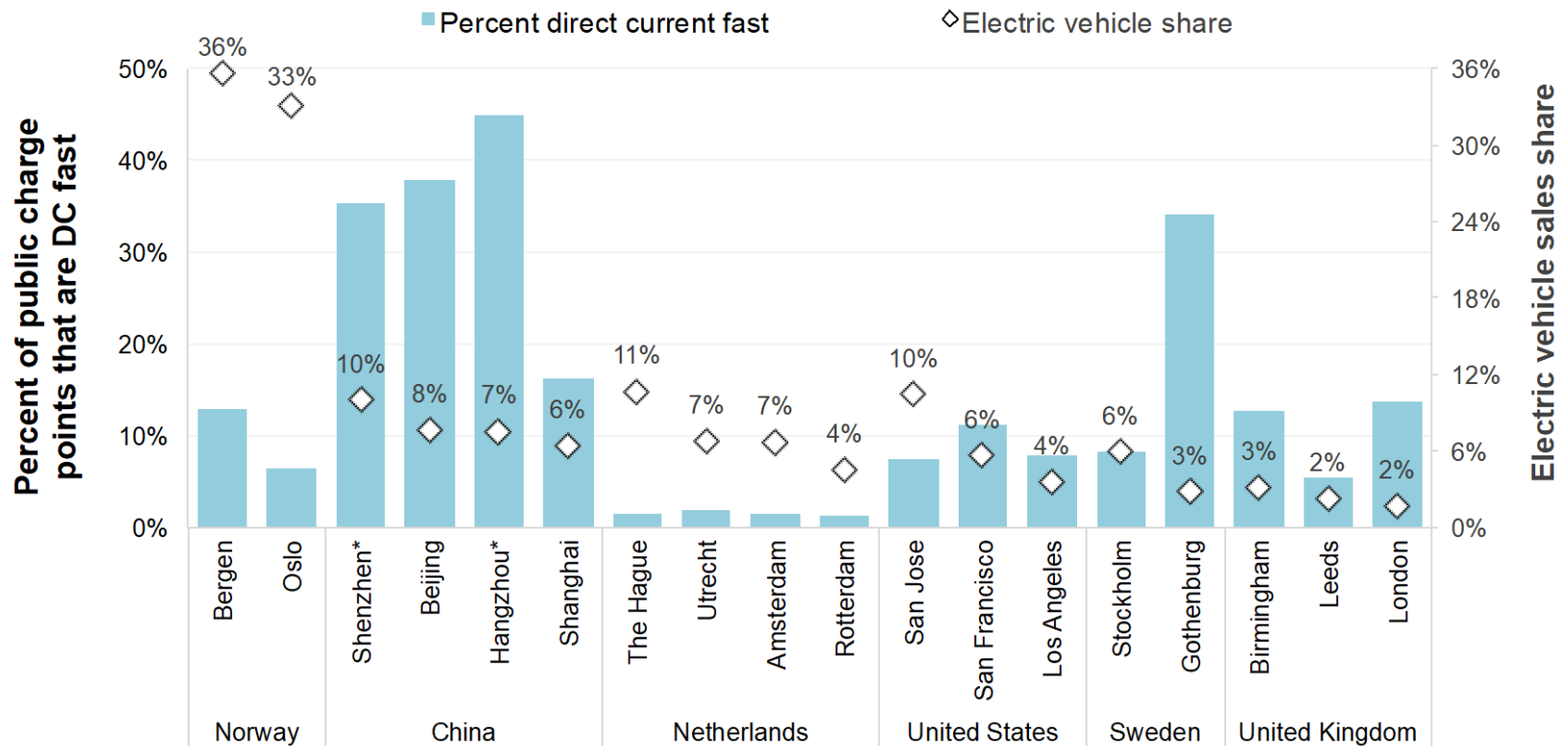
How many EVs are there per public charge point?

- Looking at the top EV markets, the EV-per-charger ratio varies greatly
 - China/Netherlands 2-7; Norway/Sweden/UK ~15-20; California ~30



How much of the public charging is rapid (DC fast)?

- Among top EV markets, the percent of public charging that is DC fast varies
 - Most markets have roughly 5-10% DC fast; but China ~40% and Netherlands 1-2%



Statistical link between public charging and EV uptake

- Multiple linear regression for electric vehicle uptake
 - Metropolitan area level (n=350), p-value <0.05, Adjusted R² = 0.78
 - Significant link between public charging (regular and DC fast) and EV uptake
 - Other factors (consumer incentives, housing, demographics) also significant

Independent variable	Coefficient	Standard Error	t Stat	P value	Beta
Consumer incentive (weighted BEV/PHEV)	0.0000059	0.0000003	18.01	0.00000	0.618
Public DC fast charging (charge points per million population)	0.0004200	0.0000400	10.87	0.00000	0.319
Public level 2 charging (charge points per million population)	0.0000300	0.0000031	9.77	0.00000	0.289
Multi-unit dwellings (percent of households)	0.0297600	0.0057000	5.22	0.00000	0.169
Population density (residents per km ²)	0.0000073	0.0000015	4.76	0.00000	0.128

Concluding thoughts

- Public charging – both regular and rapid– is linked with electric vehicle uptake around the world.
- There are no clear global benchmarks for EVs per public charge point.
 - But relationships appear to be more consistent *within* each market
 - Ratios of < 5 (Netherlands) to > 25 (California) EVs per charger have emerged in top markets
- Rich areas for future work:
 - Applying data and experience to more specifically estimate charging needs in local markets
 - Future developments: Impacts of longer-range EVs, faster DC charging, shared/autonomous
- Charging addresses convenience issues, but full suite of policy needed to address other barriers (cost, model availability) and spur EV growth

Contact

Nic Lutsey: nic@theicct.org

International Council on Clean Transportation: <http://theicct.org>

ICCT electric vehicle page: <http://theicct.org/electric-vehicles>

Acknowledgements

Analysis led by Dale Hall

This work is conducted for the International Zero-Emission Vehicle Alliance and is supported by its members (British Columbia, California, Connecticut, Germany, Maryland, Massachusetts, the Netherlands, New York, Norway, Oregon, Québec, Rhode Island, the United Kingdom, and Vermont), ClimateWorks Foundation

International ZEV Alliance: <http://zevalliance.org>