100% Electric Vehicles by 2030

Pete Ballard
Advanced Energy
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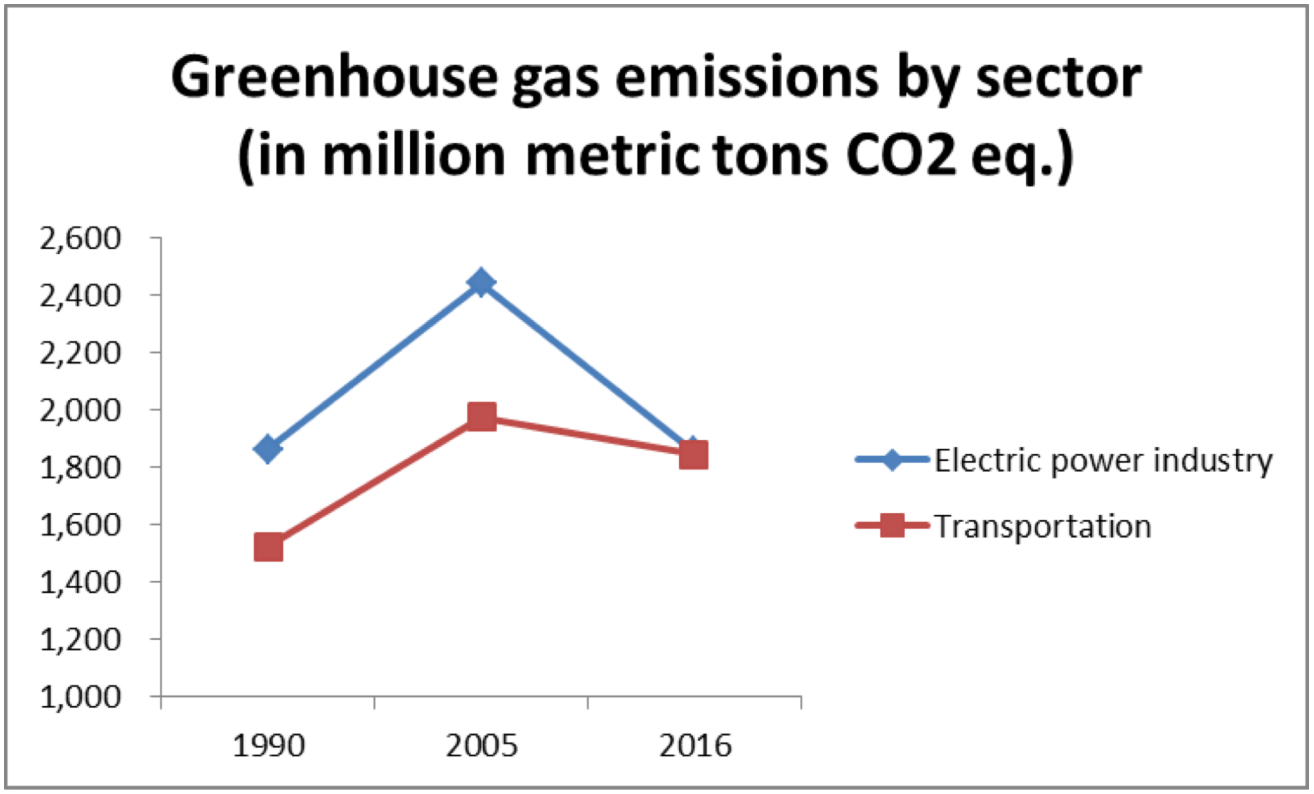
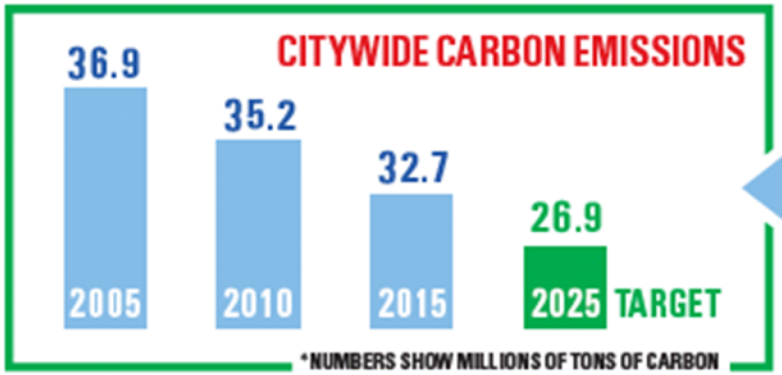
Why transportation is key to GHG reduction--nationally



Transportation GHGs in U.S. edged ahead of electric power for the first time in 2016.

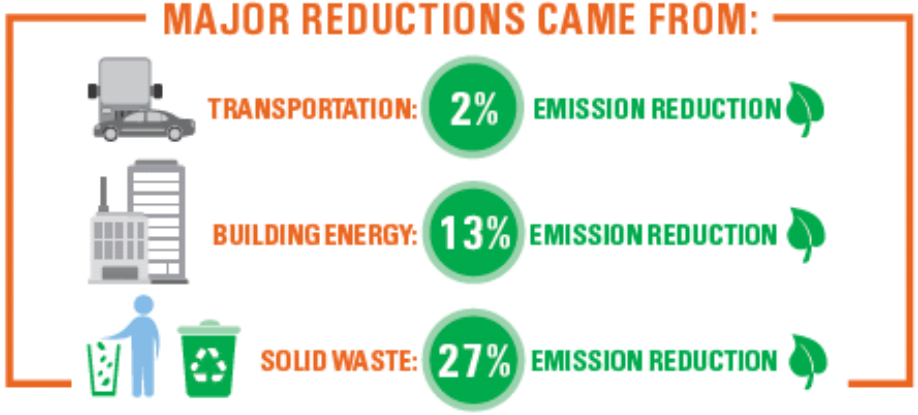
Why transportation is key to GHG reduction--locally

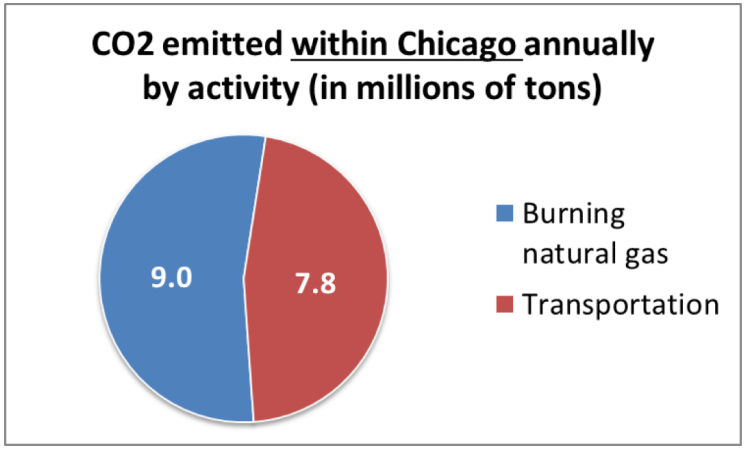


CHICAGO IS NOW **40%** OF THE WAY TO REACHING ITS PARIS CLIMATE AGREEMENT GOAL

Emissions include:

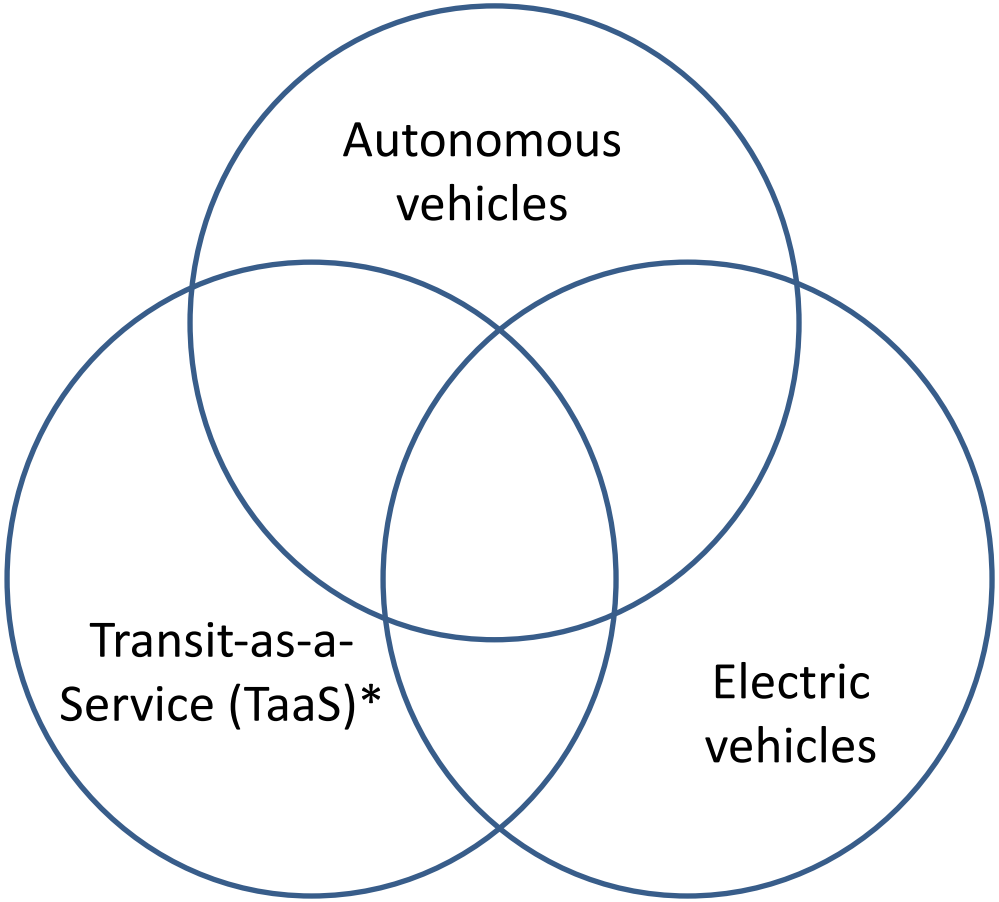
1. **Activity and emissions in Chicago (cars)**
2. **Activities in Chicago, emissions outside (power)**
3. **Activities and emissions outside Chicago (plane trip)**





- **Almost half of local CO2 is due to transportation. (10% is jet fuel.)**
- **Quicker impact of EVs: Cars replaced every 7 years; boilers replaced every 70 years.**
- **EV conversion would reduce local transportation emissions to zero.**

Transportation in the next decade: 3 revolutionary technologies developing simultaneously and interacting with each other



- Transit-as-a-Service is here and evolving.
- Autonomous vehicles are developing fast.
- TaaS-AVs in combination could increase traffic congestion and GHG emissions!
- Without EVs, it will be difficult for Chicago to reach clean energy goals.

*Transit-as-a-Service (TaaS) platforms—Uber today, AirBnB for cars coming soon

Brainteaser: What car is this?

- 200 mile top range
- Inconvenient to power up
- Initially only one model available
- End price to consumers ~$22,000

Did you guess a current EV model?

1908 Ford Model T

Dinocars* versus electric vehicles

Factor	Dinocars	Electric vehicles
Price	Standard price	~25-50% higher
Range	High, predictable	<50% of dinos, variable
Fueling/charging speed (per week)	Fast: 2 minutes	Slow: hours or days
Models available	Anything you want	Limited choices
Depreciation	~40% of value left after 5 years	Much less than 40%--battery replacement looms; newer EVs wanted.

- Electric vehicles are improving quickly, but…
- There may not be wide-scale EV adoption until they are competitive with dinocars on most of these factors.
- Incentives or mandates may provide leverage.

*"Dinocars" – powered by fossil fuels; headed for extinction?

Brainteaser: There's a fortune to be made for inventing an EV charger that does…what?

…Autonomously charges autonomous electric vehicles

Challenges beyond just the EV

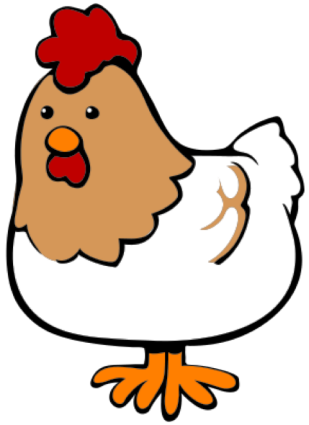
- Charging infrastructure challenges
  - Do you bring the power to the car or the car to the power?
  - Competing standards for fast charging
  - No standards for autonomous vehicles?
  - Big capital investment in technology that could be soon obsolete
  - Who pays for it? Tax payers? Rate payers? EV owners? Venture capital?

- Power generation and distribution challenges
  - ~30% more kWh electricity needed for total EV adoption
  - Matching kW demand to variable generation (solar, wind)
  - kW demand stress on grid

OK, so those are the EV challenges. Now…

You slip into a coma and wake up in 2030.
100% of vehicles are electric.
What happened?

Brainteaser: Which came first: the chicken or the egg?



Answer: It depends.

If you are a Creationist, the chicken.

If you are a Evolutionist, the egg.

When it comes to EV policy, which one are you?

EV policies: Incentive at point of purchase. But where will $ come from?

- $7,500 federal tax credit, but limit of 200,000 per manufacturer and threatened by Trump Administration
- Illinois/Chicago could offer incentive, but might be too small to matter or so popular, it busts their budgets.
- Other possible sources of incentive funds:
  - (Small) surcharge on dinocar sales
  - Sales tax reductions
  - Free Chicago city sticker/Illinois registration sticker for EVs
  - EVs eligible for utilities' energy efficiency rebates

EV policies: Financial incentives after the point of purchase

- Income tax credits
- Property tax credits
- Time Of Use incentives for non-peak EV charging
- Reduced tollway charges

EV policies: Charging installation and operation incentives

- $700-$5,000 rebate for installation (State of Maryland)
- Incentives from $1,000 to $10,000 for level 2, DC fast chargers*
- Get rid of demand charges for DC fast chargers
- Clarify regulations to allow charging station companies to re-sell electricity at point of sale

*National Association of State Energy Officials recommendations

EV policies: Top-down mandates enacted or under consideration

- Norway: only zero emissions vehicles (ZEV) can be sold after 2025; British Columbia, France 2040
- California: growing share of vehicles manufactures produce and deliver in California must be ZEV
  - Regulations are complicated, but expected to result in 8% of new car sales ZEVs by 2025
  - 10 other states have adopted, but not Illinois
- Berlin: Dinocars cannot drive/park in city center
- EV charging required for permits for new construction

Trends and technologies to watch (1)
What do these companies have in common?

- This company recently bought 500 MW of wind and solar power in Texas.

- This company owns one of the largest EV charging companies in Europe.

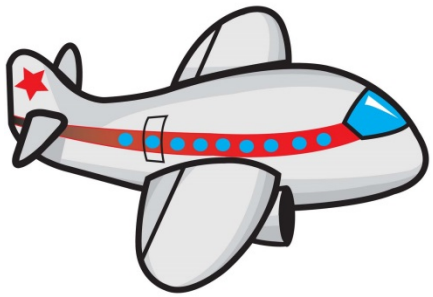
- This company just made a major investment in one of the largest EV charging companies in the U.S.

- This company just won CTA's electricity supply contract.

Trends and technologies to watch (2) “Amperium” wires

- ComEd venture with American Superconductor Corporation, funded by US Department of Homeland Security
- “The wires conduct far more power than traditional aluminum or copper lines without losing any energy from resistance or heat loss. That extreme efficiency is expected to boost resiliency on the grid, which can also make it easier to integrate renewables.”
- Allows substations to be interconnected instead of isolated so power can be rerouted.

Trends and technologies to watch (3)
The “Ion Drive” for aircraft



- “Aircraft with ion-drive creates thrust by using electrical forces to accelerate ions in a fluid to form an ionic wind .”

- That means jet “engines” with
  - No moving parts
  - No noise
  - No combustion emissions

  - And the faster they go, the more efficient they get.

“Flight of an aeroplane with solid-state propulsion”, Haofeng Xu, et al., Nature 563, pages 532–535 (2018)

The critical challenge I focus on regarding Mobility & Transportation related to Chicago's clean energy goals is:

Encouraging Electric Vehicle adoption