Fuel Cell Vehicles:

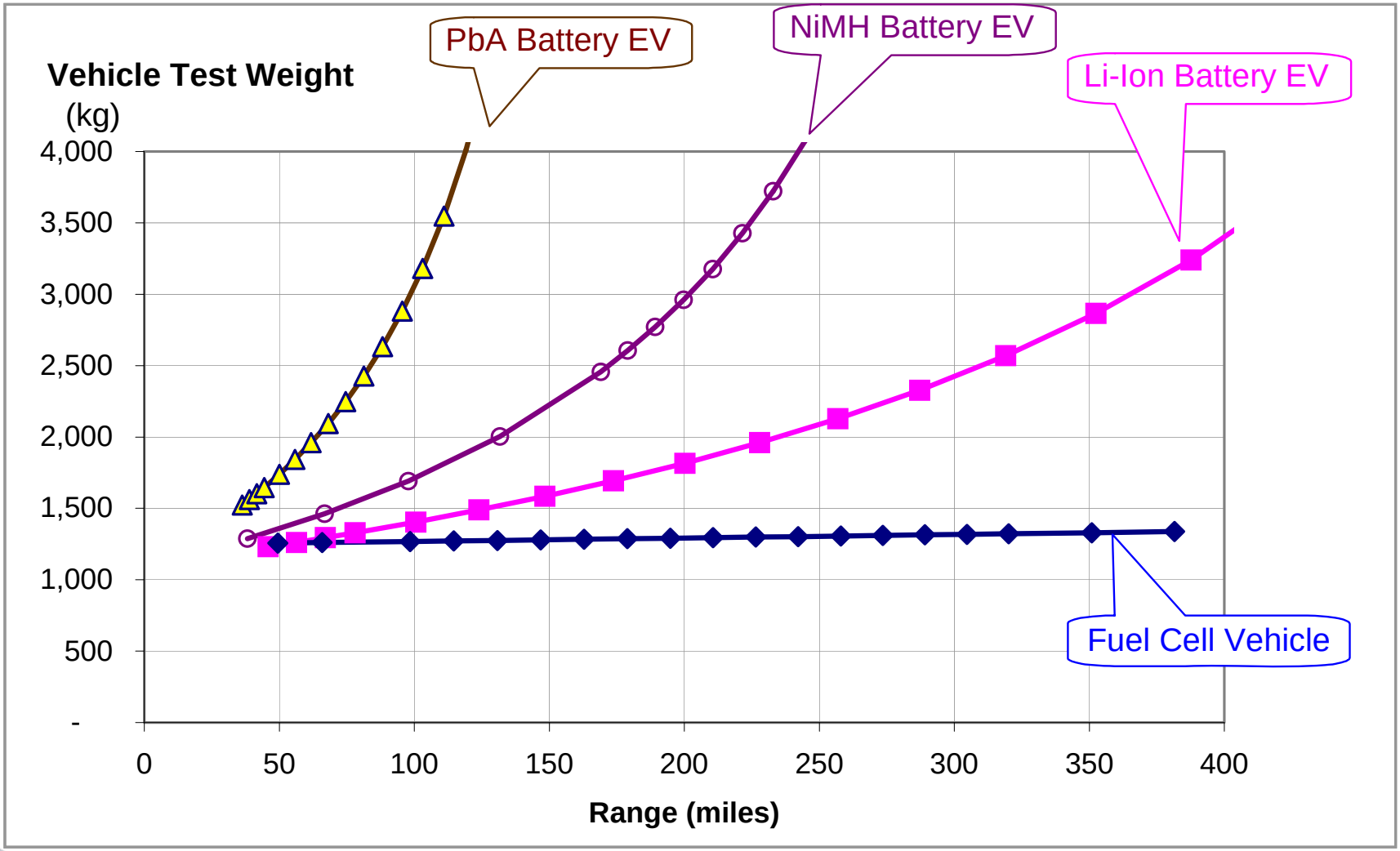
Do we need them?
When could we sell them?
Will others get there first?

Keith Cole
Director Advanced Technology Vehicle Strategies

June 12, 2009

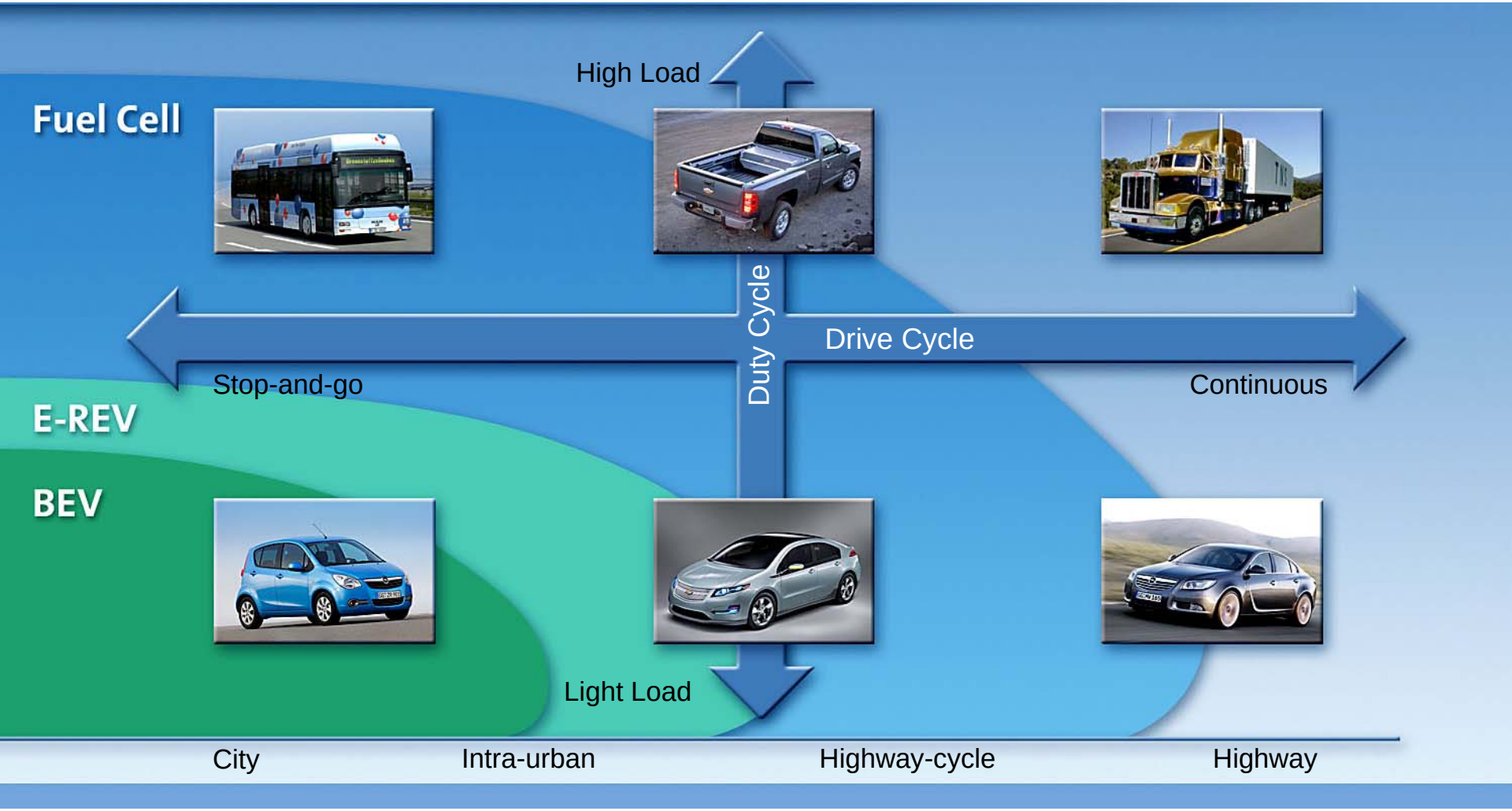
Aren’t plug-ins enough?

Batteries face challenges with increased range and for larger vehicles



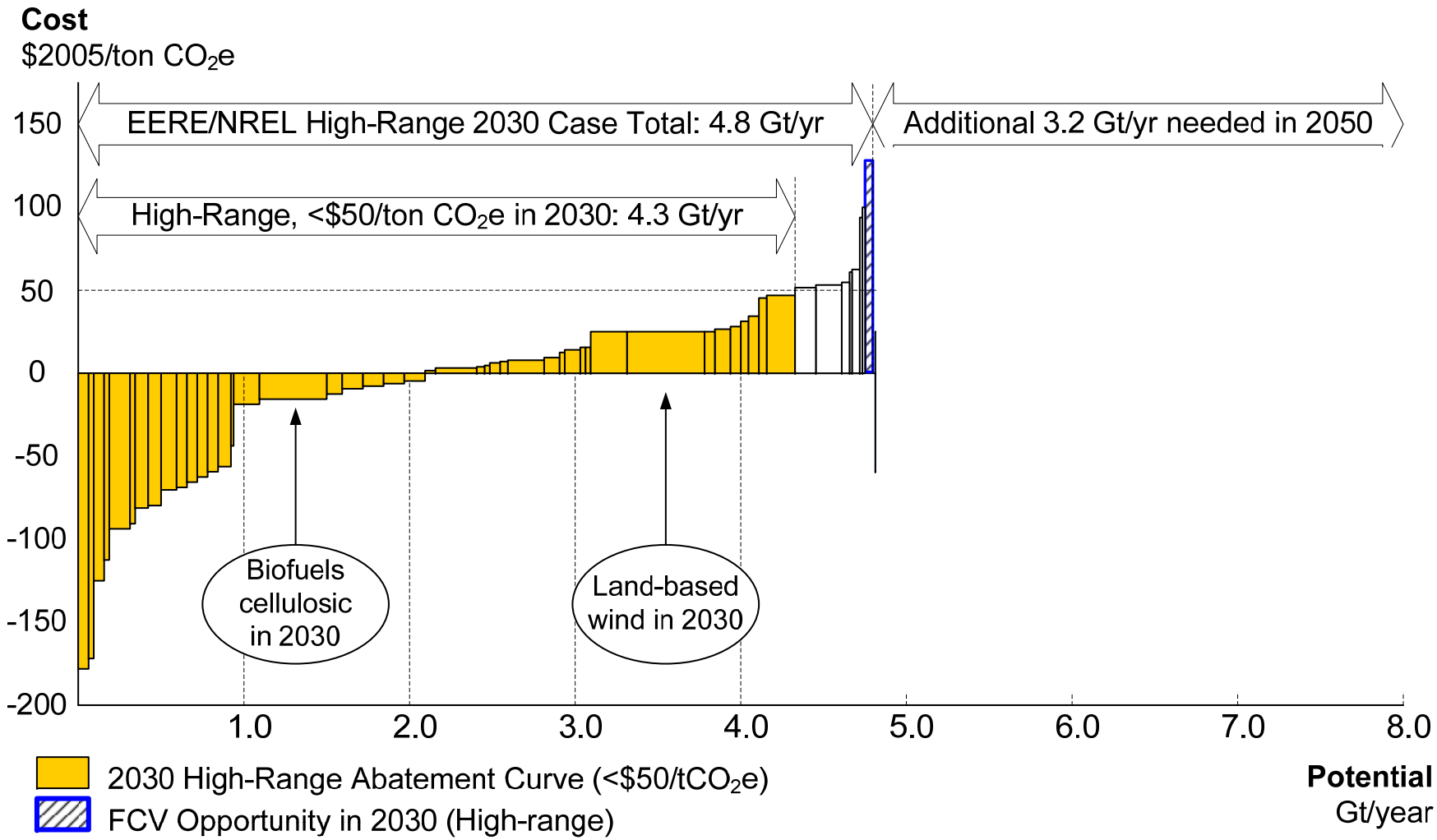
H2Gen: BPEV.XLS; WS 'Compound' AF137 8/26 /2006

Application Map for Electric Vehicle Technologies



No Silver Bullet !!!

DOE / McKinsey data on Carbon Abatement Costs



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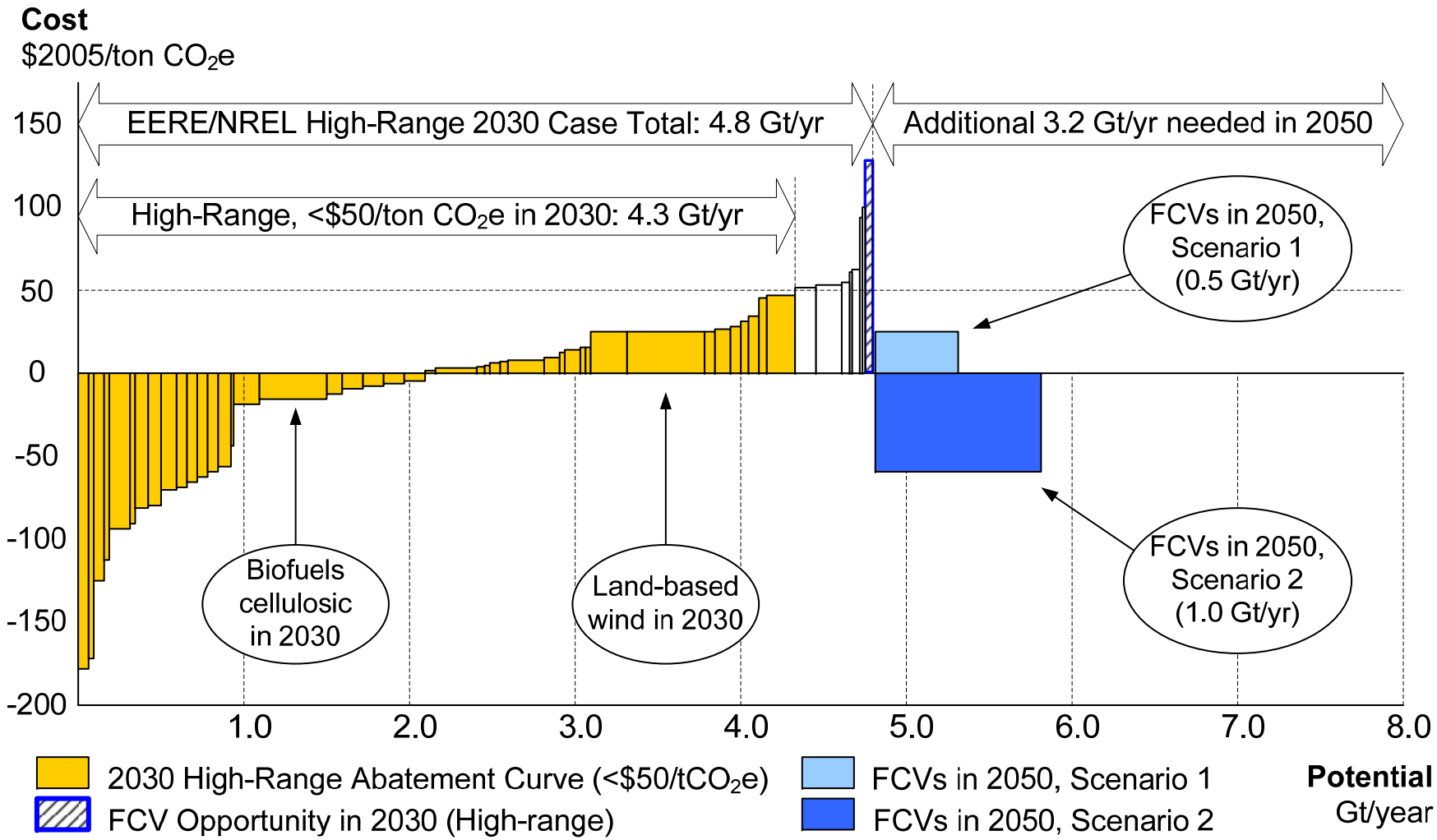
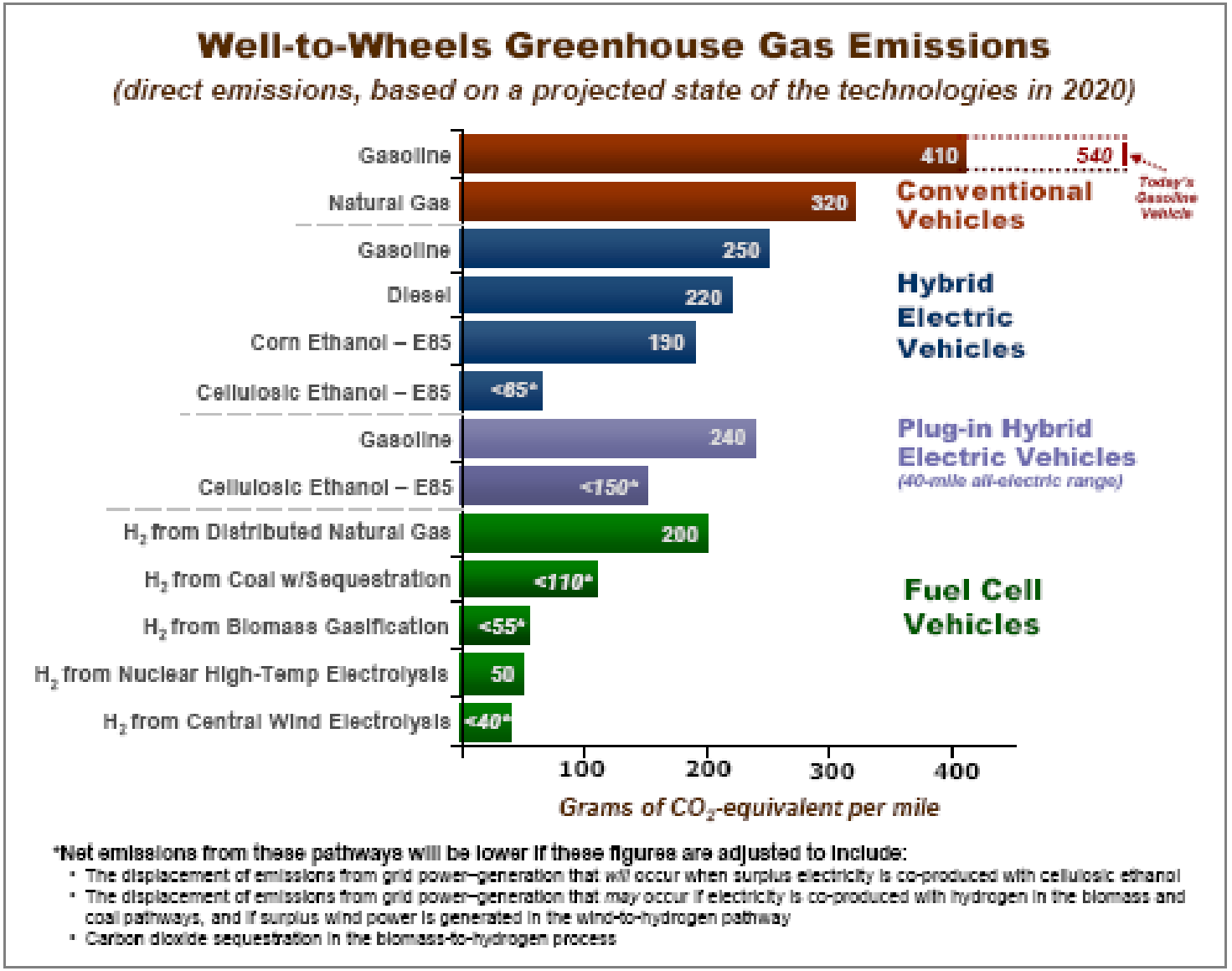
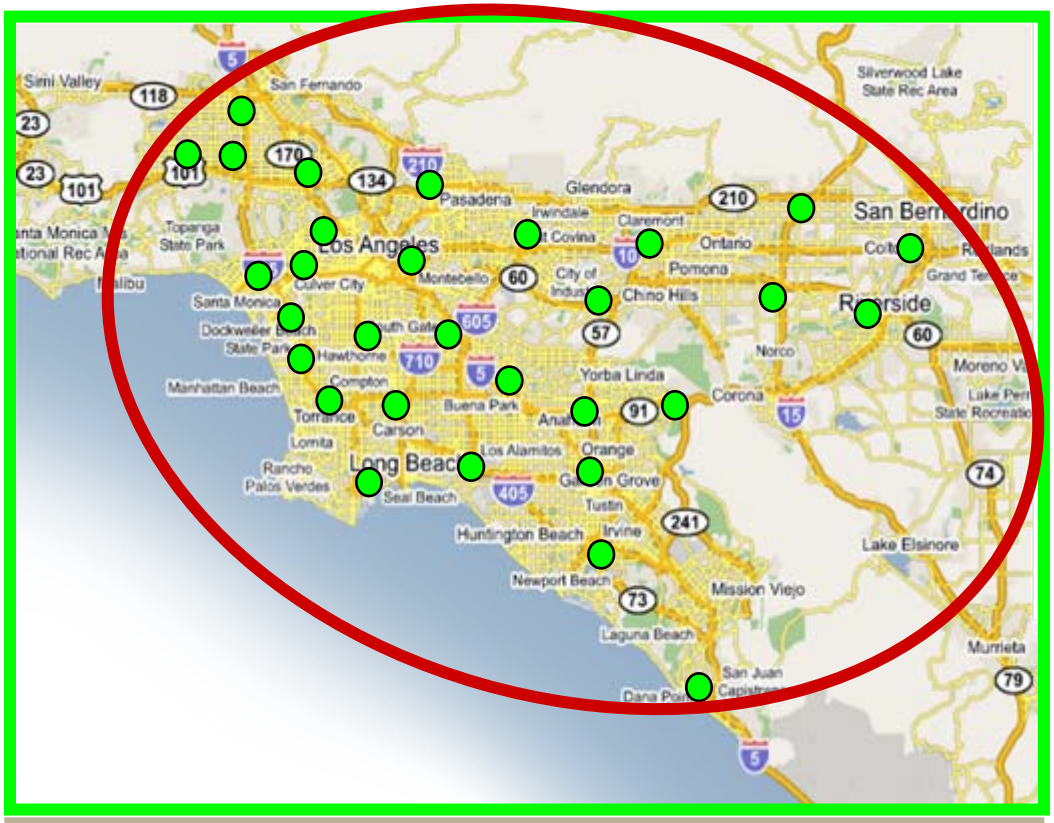


Hydrogen from Nat Gas – a GHG Comparison



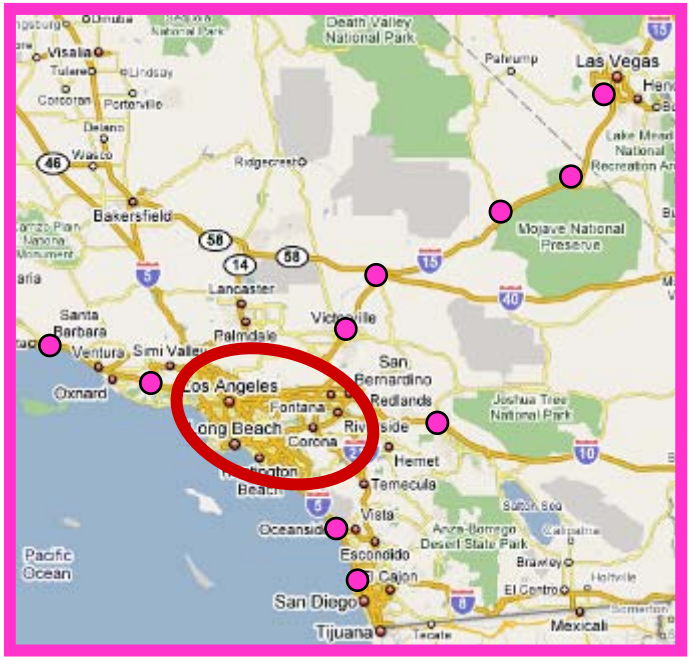
Solar Hydrogen refueling today

Infrastructure –
Needs good policy - not a breakthrough

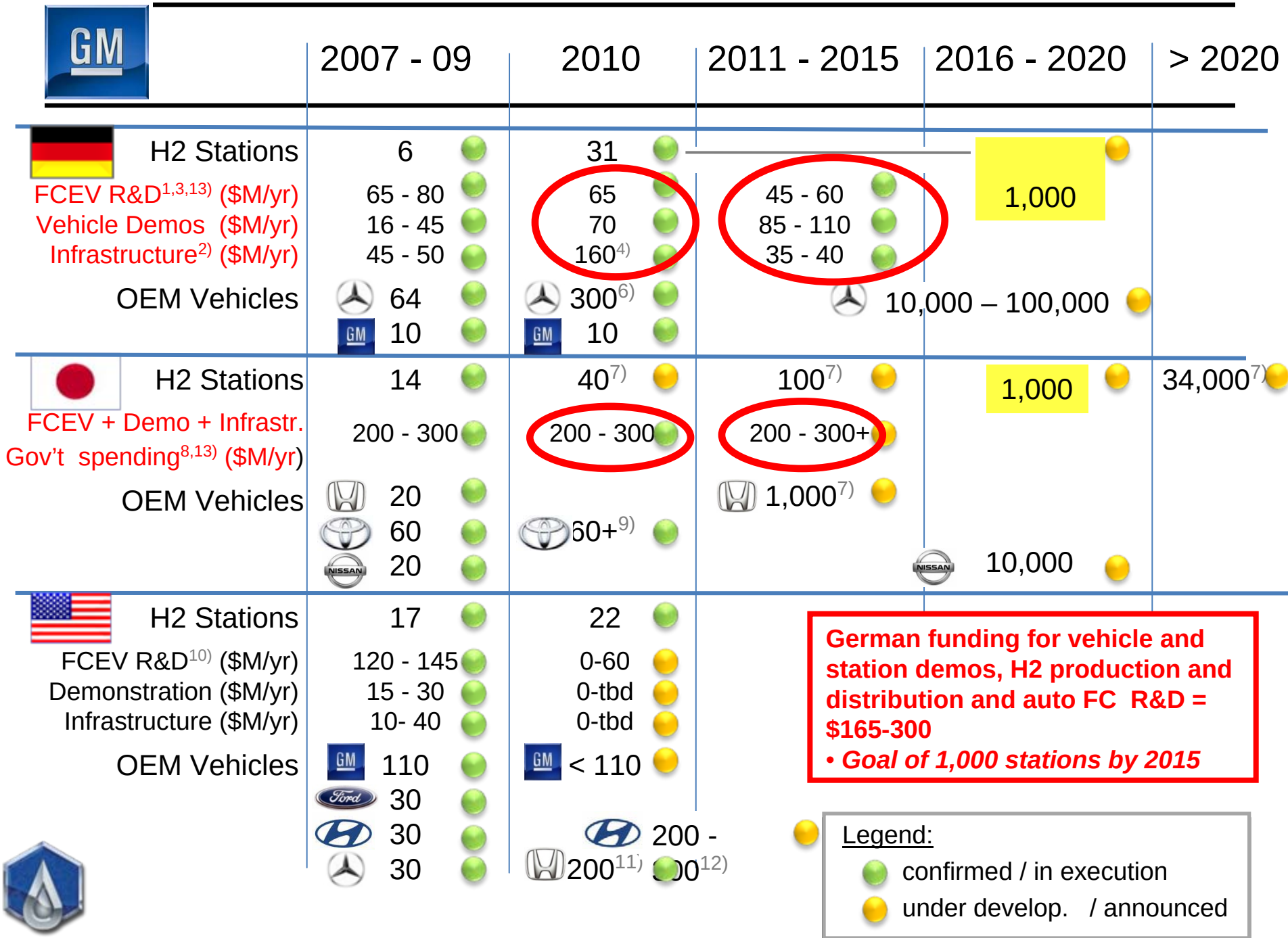


~ 30-40 stations needed in LA Metro Area (illustrative) – average distance ~3.6 miles

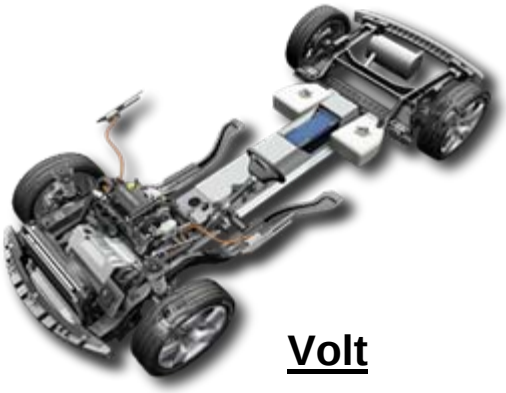
10 stations for Destination Corridors



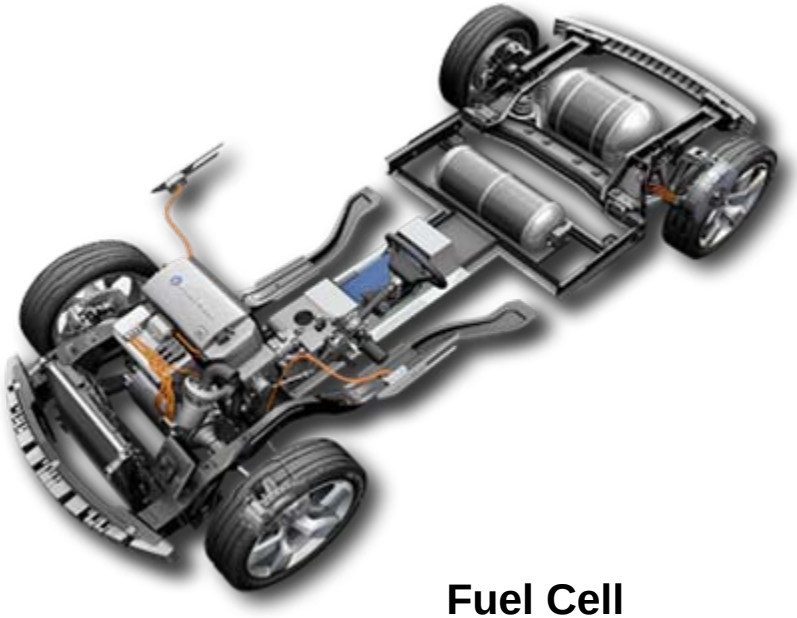
~$100-200 M could open a market of ~15 million consumers


GM
2007 - 09
2010
2011 - 2015
2016 - 2020
> 2020
H2 Stations
6
31
FCEV R&D[1,3,13] ($M/yr)
65 - 80
65
45 - 60
Vehicle Demos ($M/yr)
16 - 45
70
85 - 110
Infrastructure[2] ($M/yr)
45 - 50
160[4]
35 - 40
1,000
OEM Vehicles
64
300[6]
10,000 – 100,000
GM 10
GM 10
H2 Stations
14
40[7]
100[7]
1,000
34,000[7]
FCEV + Demo + Infrastr.
Gov't spending[8,13] ($M/yr)
200 - 300
200 - 300
200 - 300+
OEM Vehicles
20
1,000[7]
60
60+[9]
20
10,000
H2 Stations
17
22
FCEV R&D[10] ($M/yr)
120 - 145
0-60
Demonstration ($M/yr)
15 - 30
0-tbd
Infrastructure ($M/yr)
10- 40
0-tbd
OEM Vehicles
GM 110
GM < 110
30
30
200 -
30
200[11]
[12]
German funding for vehicle and station demos, H2 production and distribution and auto FC R&D = $165-300
• Goal of 1,000 stations by 2015
Legend:
confirmed / in execution
under develop. / announced

FC Vehicle Commercialization



Volt



Fuel Cell

What must be true?

- **Staying the course on a national vision**
- **Fully fund DOE's FC vehicle program – with increased focus/ $$ on early commercialization and domestic production by ~2015**
- **Incremental progress on FC cost and durability**
- **Designing a vehicle with hydrogen storage for a 300+ mile range**
- **Use Clean, NG-derived H2 today – even lower-carbon H2 over time**
- **$250 M to kick of a regional H2 refueling infrastructure in 1-2 regions**

Key Points

- With long term goals like 80% GHG reduction in 2050, the transportation sector can't get there with just efficiency, biofuels and batteries – we need fuel cells in the portfolio
- Hydrogen/FCs can fill this gap and enable electric vehicles in more applications - and could get us to the 80% goal in 2050
- Industry is meeting or exceeding DOE's well vetted FC commercialization targets – which aim for commercial viability in 2015
- Fuel cell cost, range, hydrogen storage, source of hydrogen, infrastructure can be addresses without "breakthroughs"
- If fuel cells were a "head fake" nobody told the autos – we are making it happen
- Other countries are pursuing a portfolio that includes H2 FCs - and are moving aggressively to a ~2015 target date for early commercialization
- We can be there too - or we can let the technology go, as we did batteries, etc.
- Predicting the future is hard, and all projected progress contains technological risk - a portfolio approach minimizes this risk
- Considering the money spend on the other technologies, preserving the fuel cell option is smart - a cheap hedge

It's too early to take hydrogen fuel cells out of the portfolio of advanced technology vehicles