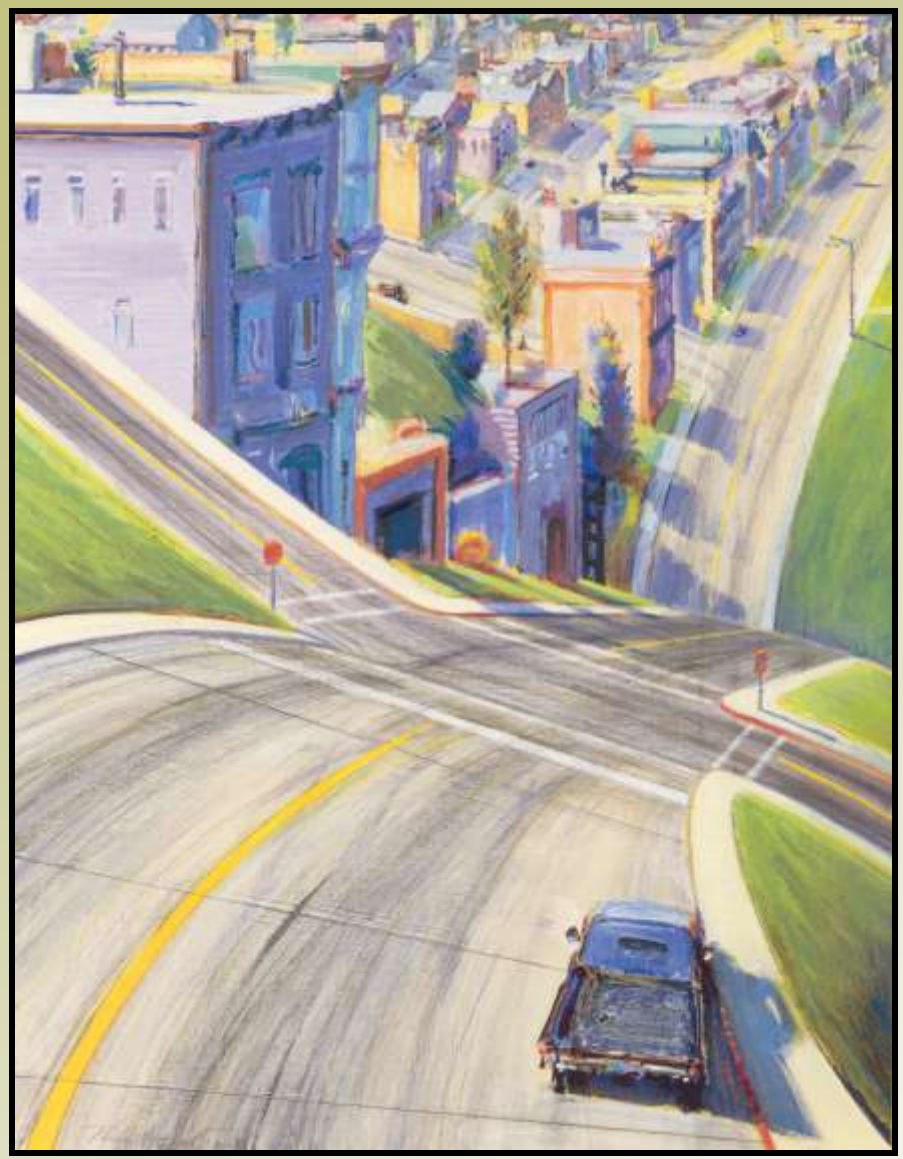

Exploring the future of fuel consumption choices

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20 years of hands on studies on consumers & alternative fuels at ITS

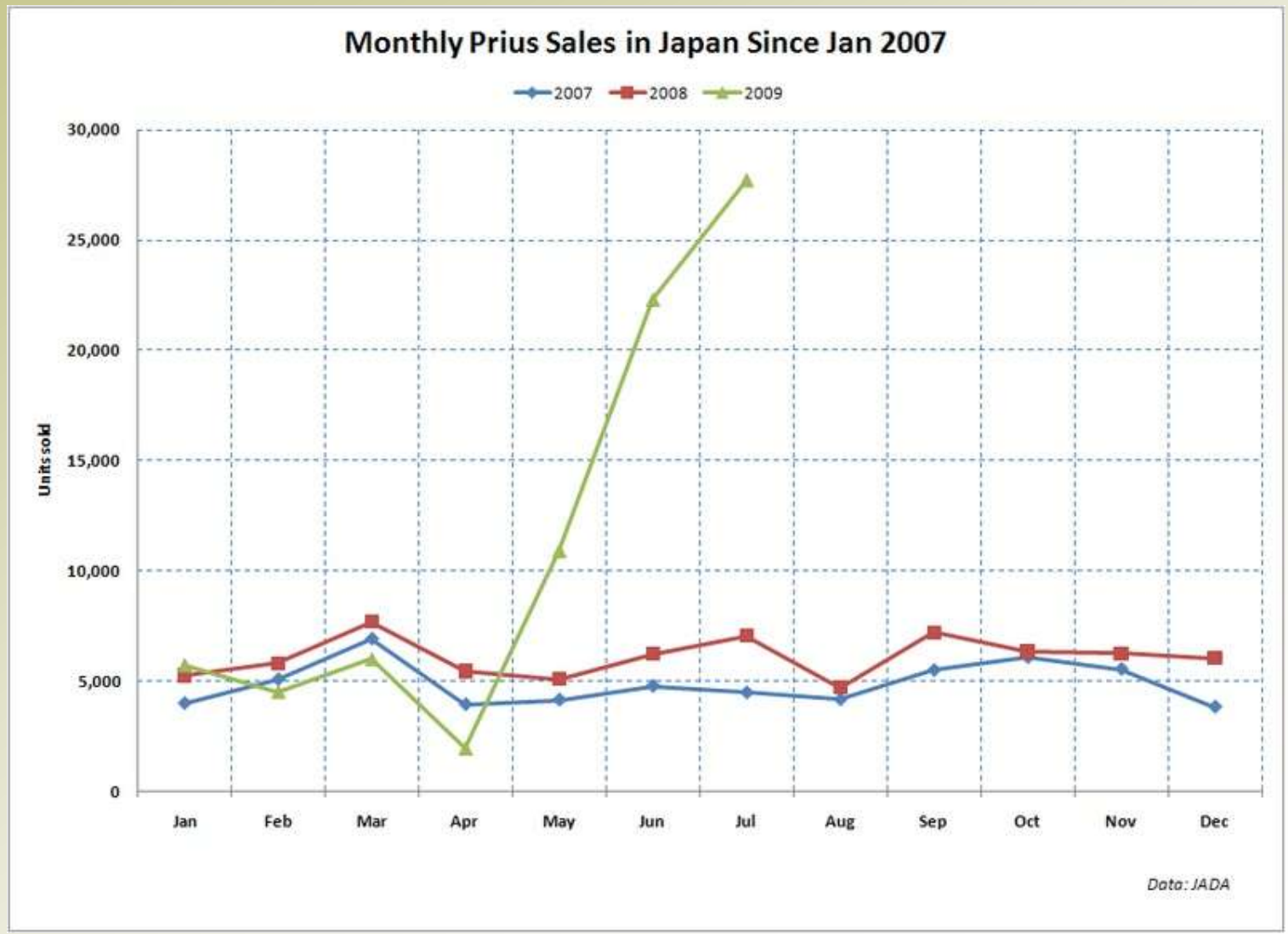
- 1988 Diesels in California
- 1989-1990 Compressed Natural Gas Vehicles in New Zealand & Canada
- 1991-1996 Electric vehicles in Calif. (interviews, surveys and test drives)
- 1996-2001 Neighborhood EVs & City Electrics (Nissan Hypermini project)
- 2002-2004 Consumers & fuel economy decisions
- 2002-2005 Fuel cell vehicles and consumers (Toyota Highlander FCHEV)
- 2003-2006 Hybrid buyers studies (Ford Escape: Toyota Prius, Highlander: Honda Insight, Civic, Accord; Nissan Altima)
- 2007-10 PHEV drivers (national survey and converted Priuses in households)
- 2009-10 BEV drivers (MINI E)
- 2010-12 BEV charging behavior with ETEC/Nissan
- 2010-12 PHEV Prius conversions in state fleets
- 2010-13 PHEV P-ups in SF city fleets, Chrysler
- 2010-12 BEVs in China (VW)

Plug-in Hybrid Research Center Kick-off

So what have we learned? What are advanced, green vehicle choices about?

Change happens”: Japan’s market shifted radically last year

Prius now best selling non-K car in Japan most of 2009, Honda Insight was best selling earlier in year



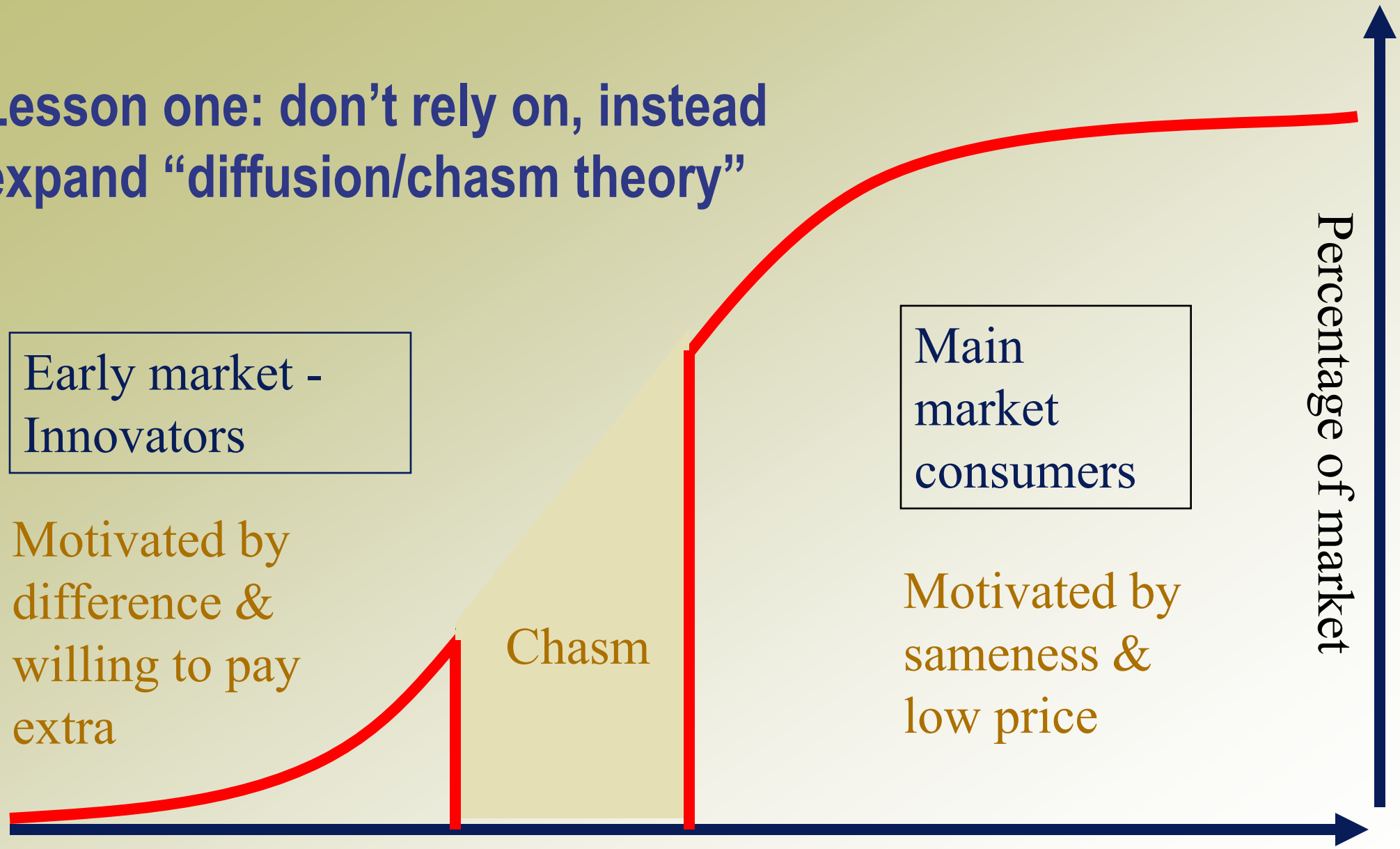
If you have the time.. study social processes and technology users

Lifestyles,Cultural values, Social networks

vehicles are very public

church, school, workplace

Lesson one: don't rely on, instead expand "diffusion/chasm theory"



And: if you got to do economics, at least get with the new consumer theory in economics:

- Old stuff: neo-classical utility theory (A. Marshall 1900)
  - spend your money to buy things with most utility
- New stuff: (Gary Becker 1992 Nobel Prize)
  - Household consumption production: Household is like a firm, which combines:
    - Consumption capital (knowledge)
    - Money
    - Tools and
    - Time
  - To create consumption outputs “think about family vacations, wine aficionados, skiers, gardeners, amateur photographers”

US consumer experiences & manufacturer designs have been shaped by low fuel costs.

- At time of purchase:
  - The MPG sticker on the car (forgotten by many drivers a few months after purchase)
  - A difference between big car and little car; powerful, fast car and slow cars; cheap car and luxury car
- During ownership:
  - The cost of a last tank of gas; the price of fuel at the pump; the miles between refueling.
    - Lots of variability in last few years- $2-4 a gallon, up to $100 a tank on big cars
  - Instrumentation:
    - A readout on the dash board in some cars,
    - A calculation made by keeping record on gas receipts
  - The experience of fuel use while driving fast, hard (foot to the floor)

The experience of fuel economy for consumer has not been…..

- At time of purchase:
  - Not understood, or broken out as part of the cost of a vehicle at a dealership
  - Not understood as a function of a pay-back calculation, especially a 3 year payback with a discount rate
- During ownership:
  - Not experienced as an annual expense
  - Not though of either as a life-time cost

The fuel economy experience & perception is being restructured through new technology, in particular electric drive & the historical nexus of climate change and oil security/supply issues.

Bigger Engines ← → *Bigger Batteries*

Internal Combustion Engines (ICEs)

Hybrid Electric Vehicles (HEVs)

Lite → Mild → Full

Toyota Prius HEV / Honda Civic HEV

Plug in Hybrid Vehicles (PHEVs)

PHEV 5 → 60 Miles
Blended → AER

Prius Plus 20 PHEV
GM Volt 40 PHEV

Electric Vehicles (EVs)

50+ mi.

Tesla EV

Gasoline/Diesel Dependent

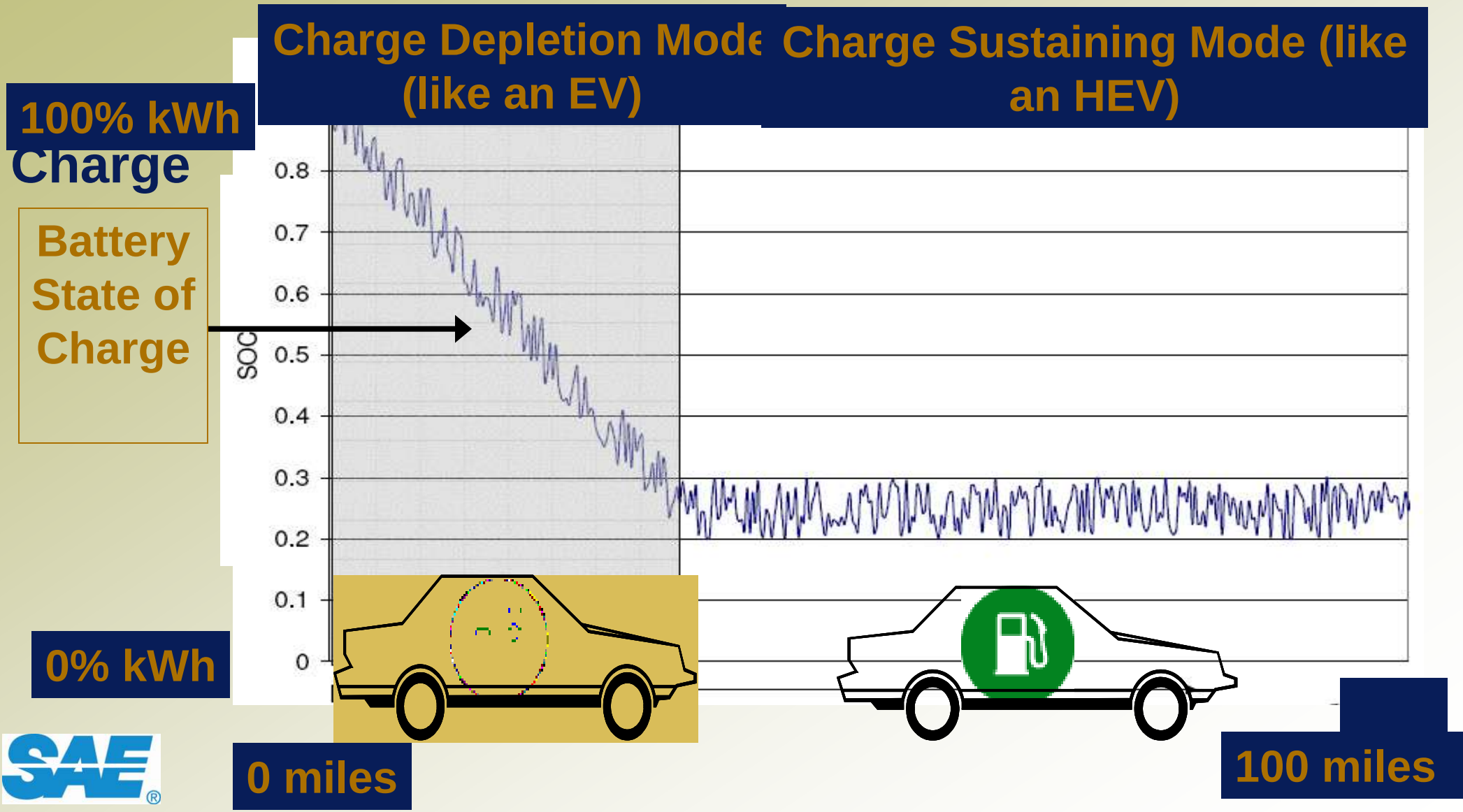
Electric Grid Dependent

HEV energy displays and HEV influence driver behaviors and change their experience of fuel economy

- HEV buyer spend lots of time looking at screen in first year
- HEV owner show researchers the screens, not the engine
- HEV owner understand and “value” their vehicle through their instruments
- HEV owner learns how fuel economy varies over speed, terrain, weather

Tai Stillwater, PhD student

In PHEVs, fuel economy combines mpg & kWh mile, & changes over course of trip.



With BEVs, drivers pay different fuel prices at night, at home, at work, at stations.

- Vehicle efficiency is a central experience of technology
  - Regenerative braking
  - Battery capacity and use
  - Vehicle charging
- Fuel costs are linked to home, monthly bills

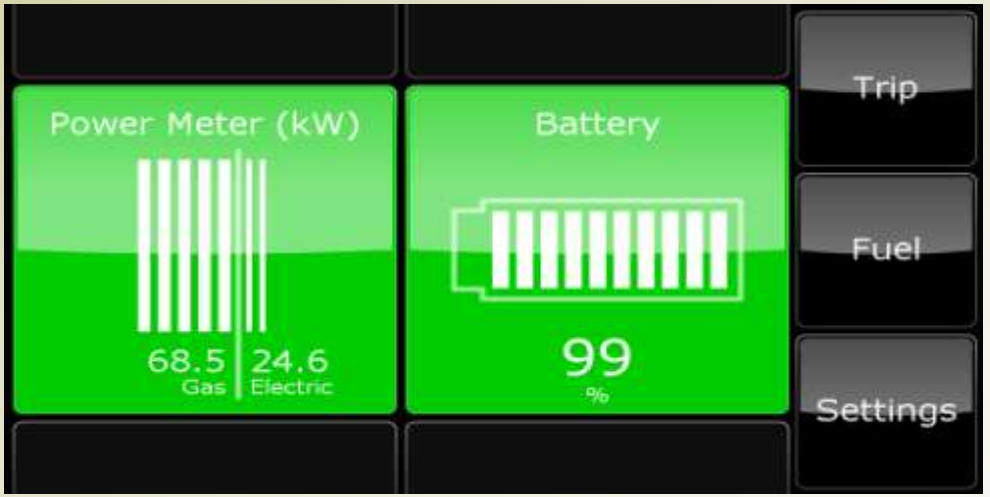
BMW MINI-E Project Launch

Fuel economy for consumer is increasingly…….

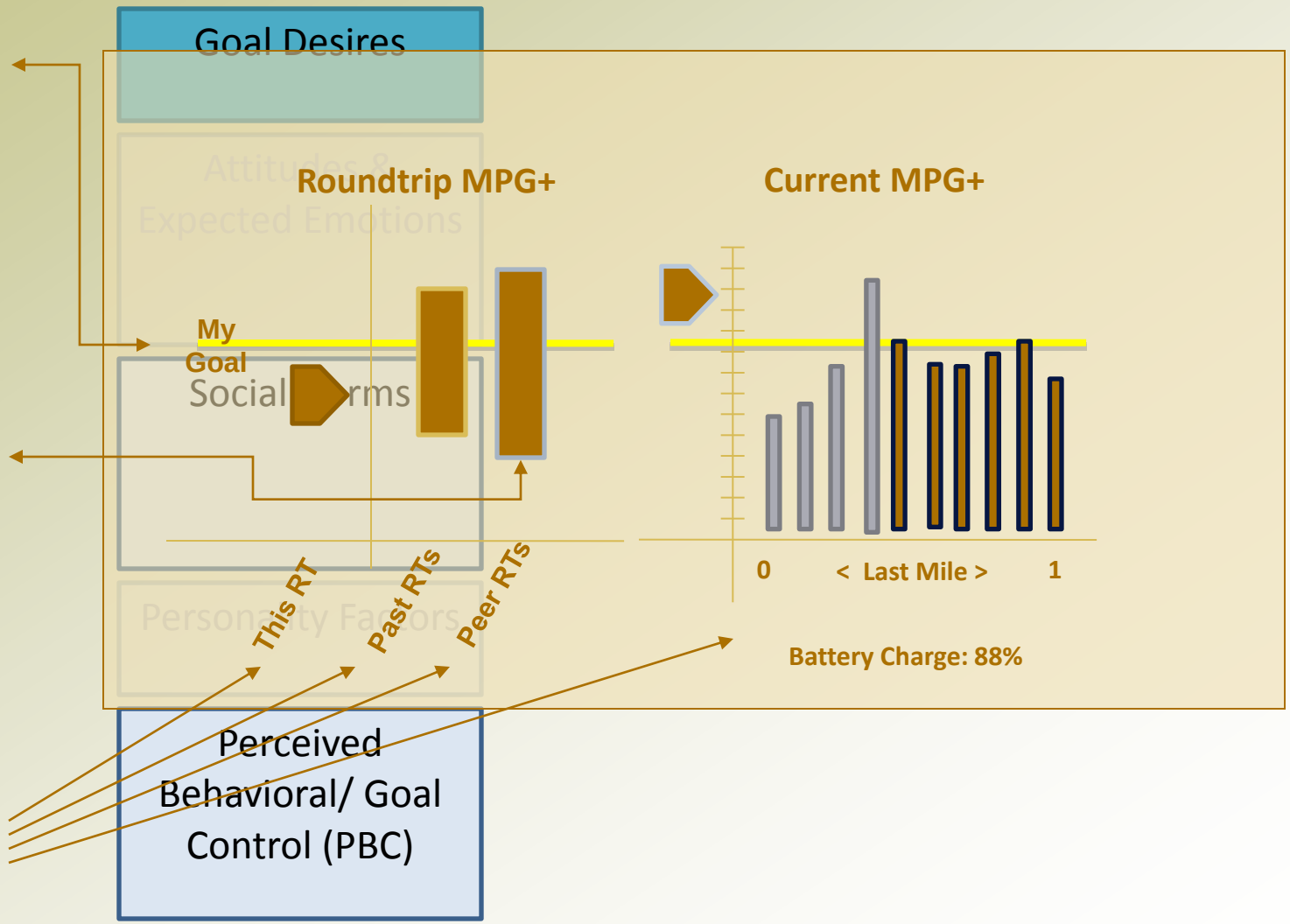
- Understood as a feature of technological advancement
  - Advance vehicles are efficient (and have better fuel economy)
  - Advance vehicles use hybrid technologies
    - Advance vehicles get energy back from brakes and down-hills
    - Advance vehicle have fancy instruments for fuel economy information
  - Advance vehicles use electricity
    - Gas stations are so old economy; we will charge at home & at work
- Understood as having a relation to social/environmental issues
  - As a pollution, resource conservation issue, and to some Americans (lots of Europeans) as a climate issue
  - Understood as having a relationship to importation of oil
    - Oil companies are corrupt, oil countries are evil

New user interfaces are designed by UC Davis to explore the new fuel economy.

- **Real time cost per mile:**
- **Real-time CO2;**
- **Trip, daily and total average fuel economy**
- **Electricity & gasoline use compared over time, distance, journeys**



Eco-Driving Interface Based on the Extended Model of Goal Directed Behavior



Recharging of electric vehicles & plug in hybrids changes perceptions

- Refueling at home becomes a default reference for EV drivers
- Electricity viewed as newer, cleaner, cheaper (even though car costs more)
- Gasoline stations are viewed as archaic, unsafe, crowded locations by BEV drivers

Some final thoughts…

- Its not just about costs (although a recession forces more emphasis on costs) and when it is, it is as much about values as preferences
- Education of consumers (the schools, churches, workplaces) and is shaped by vehicle instruments
- Its about life style choices, very public values