Project EVolve

Product Opportunity Assessment

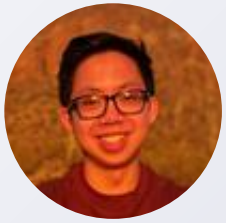
Team Ford: Aniket, Claire, Erika, Philip, Pranjal, & Zac

Meet Team Ford:

Zac Ettensohn
MS MS&E

Aniket Bhátia
MS EE

Pranjal Agarwal
MS MATSCI



Philip Phan
MS AeroAstro

Erika Francks
MS Product Design

Claire Rosenfeld
BS CS + MS MS&E

Agenda

1. Customer and Job to Be Done
2. Market Investigation
3. Competitive Analysis
4. Technical Feasibility
5. Risk Identification
6. Next Steps

How might we...

...help Ford leverage the electric vehicle transformation from a means of conveyance to an amplifier of an individual's electric lifestyle and beyond?

Our process

Opportunity mapping

- Demand response
- Awareness
- Charging
- Grid services
- Fleet management
- etc.

Research & Interviews

- EV owners
- Non-owners
- Fleet managers
- Battery experts
- EV engineers
- Truck owners
- Demand response
- etc.

Job to Be Done & POA

- Ideation
- Converging
- Problem validation
- Market exploration
- Feasibility
- etc.

We interviewed across the ecosystem

Car owners (EV & gas)

Truck owners

Battery experts

Demand response companies

Fleet managers

EV engineers / researchers

Charging is top of mind

We interviewed across the ecosystem

Car owners (EV & gas)

Truck owners

Battery experts

Demand response companies

Fleet managers

EV engineers / researchers

"When I charge I try to charge off-peak hours [at night]. I want my charger to match my patterns.

–Margaret, Tesla owner

"I pay extra on my electricity bill to use more renewable energy.

–Heather, Subaru Crosstrek owner

"I am concerned about additional costs associated with smart charging.

–Richard, EV owner

We interviewed across the ecosystem

Car owners (EV & gas)

Truck owners

Battery experts

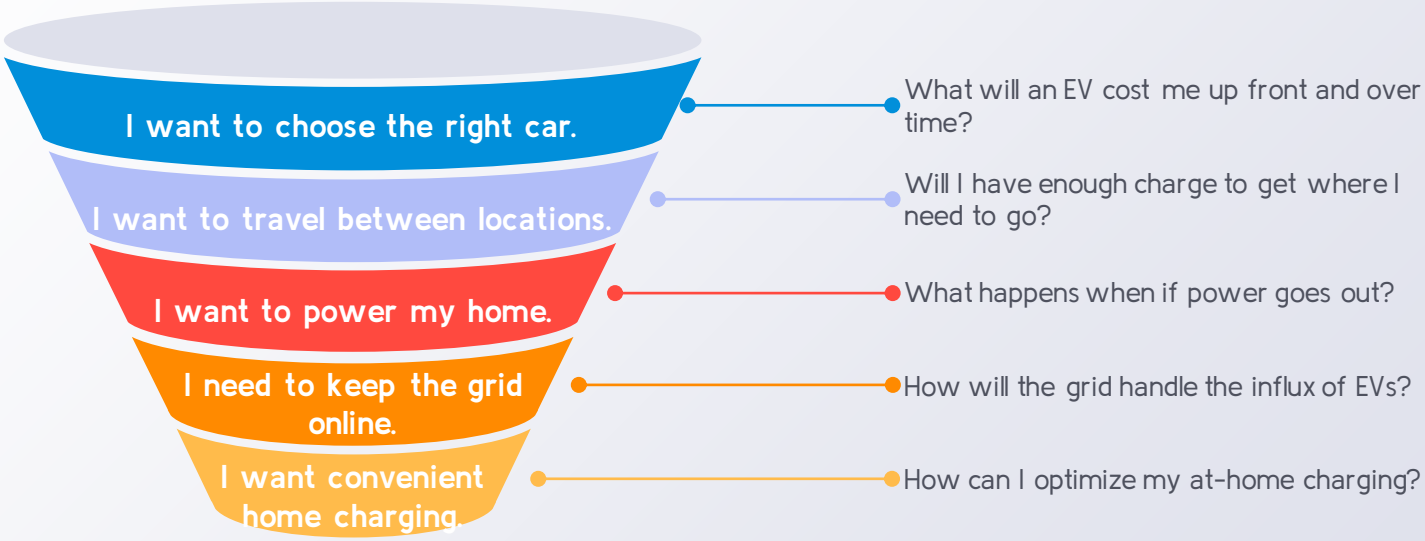
Demand response companies

Fleet managers

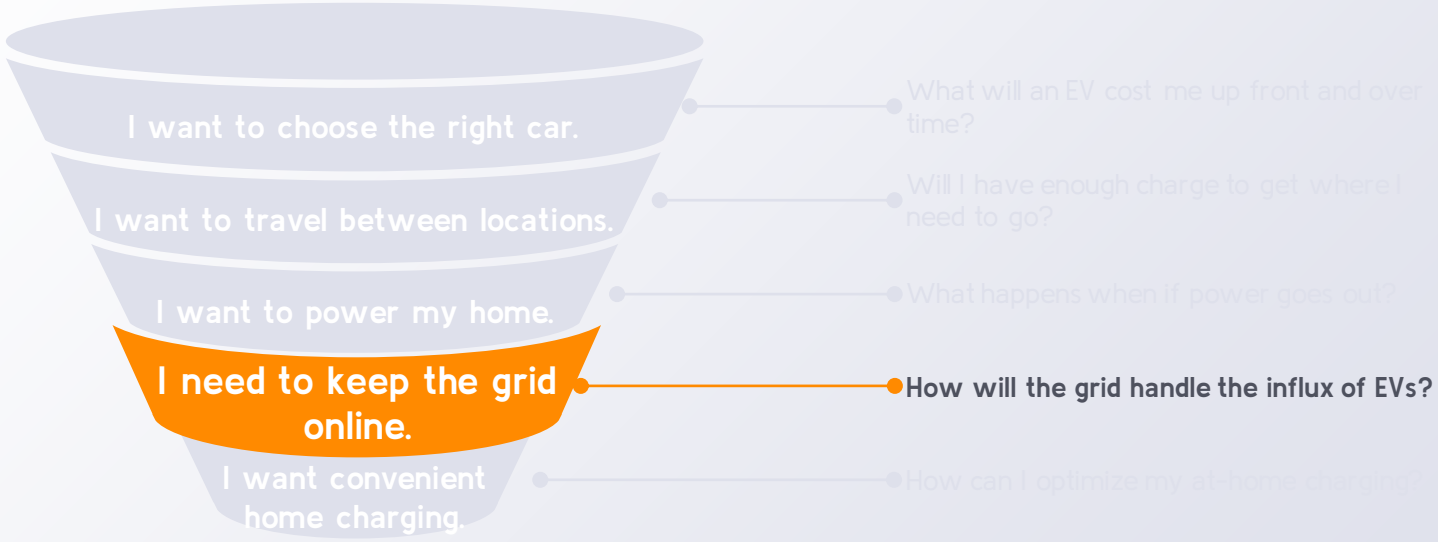
EV engineers / researchers

> Electrifying everything is hip to say, better than the alternative, but the grid is fragile as-is.
>
> -Alex, demand response analyst

Narrowing in on our Job to Be Done



Narrowing in on our Job to Be Done



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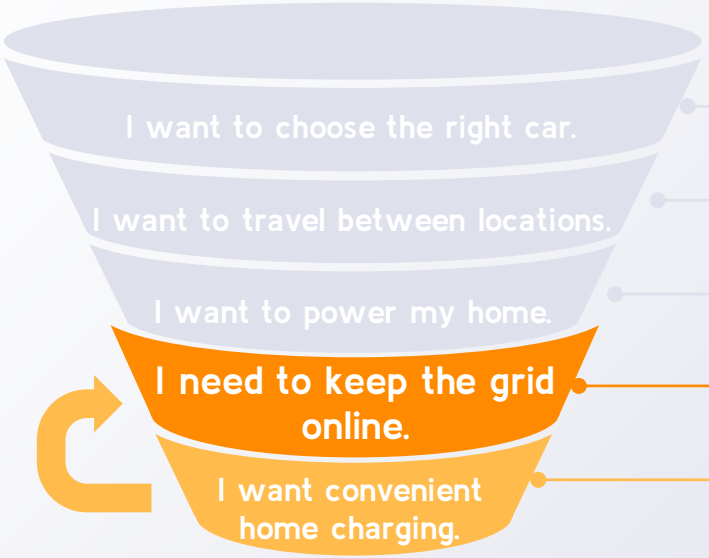


What will an EV cost me up front and over time?

Will I have enough charge to get where I need to go?

What happens when if power goes out?

How will the grid handle the influx of EVs?

How can I optimize my at-home charging?

"The Grid"

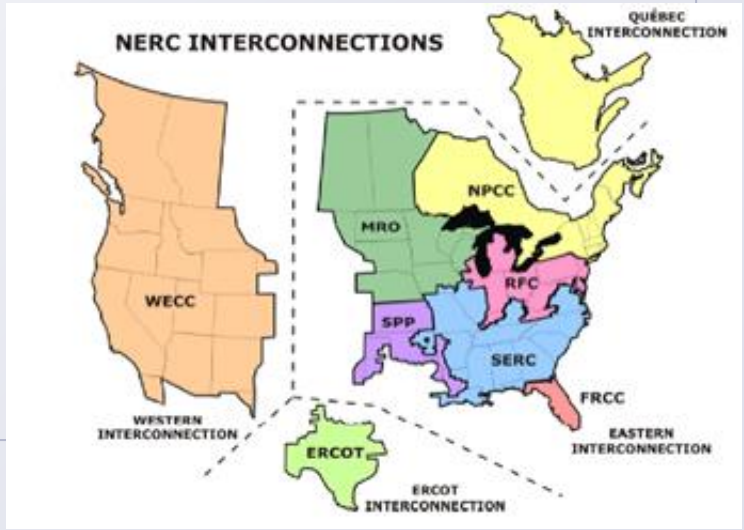
- A **network** of power plants, transmission lines, and distribution centers
- Manages **supply and demand** of energy

7,700 power plants

3,300 utilities

2.7 million miles of power lines

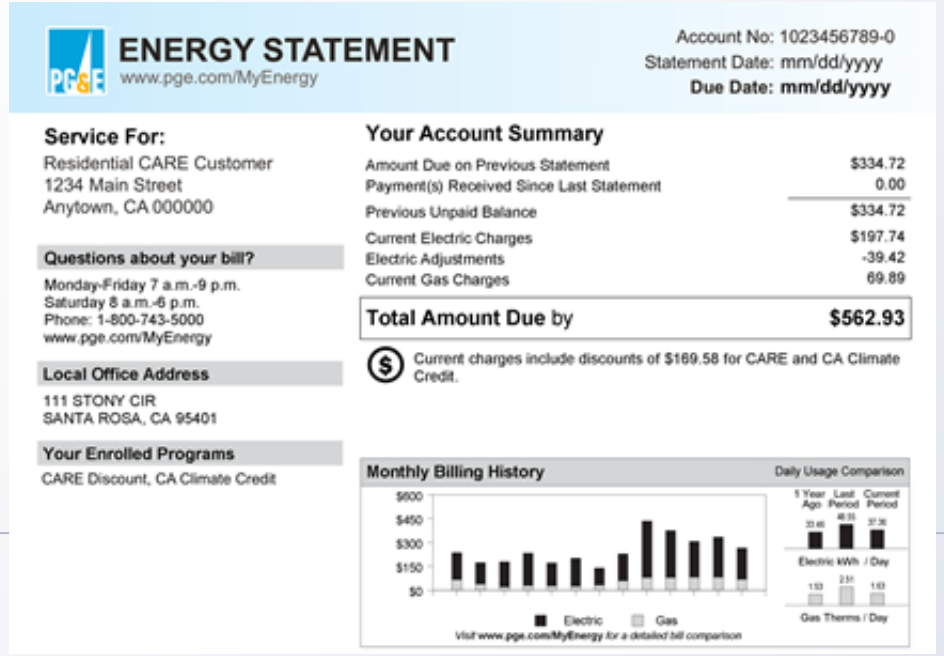
REGIONAL RELIABILITY ORGANIZATIONS MANAGE BULK POWER TRANSMISSION ACROSS NORTH AMERICA



INDEPENDENT + REGIONAL SERVICE OPERATORS OVERSEE REGIONAL ELECTRICITY MARKETS

CAISO mission: "**operate the grid** reliably and efficiently, provide fair and open **transmission access**, promote environmental stewardship, and facilitate effective **markets** and promote **infrastructure** development."

UTILITIES COMPANIES SERVICE LOCAL TERRITORIES



ENERGY STATEMENT
www.pge.com/MyEnergy

Account No: 1023456789-0
Statement Date: mm/dd/yyyy
Due Date: mm/dd/yyyy

Service For:
Residential CARE Customer
1234 Main Street
Anytown, CA 000000

Questions about your bill?
Monday-Friday 7 a.m.-9 p.m.
Saturday 8 a.m.-6 p.m.
Phone: 1-800-743-5000
www.pge.com/MyEnergy

Local Office Address
111 STONY CIR
SANTA ROSA, CA 95401

Your Enrolled Programs
CARE Discount, CA Climate Credit

Your Account Summary

Amount Due on Previous Statement	$334.72
Payment(s) Received Since Last Statement	0.00
Previous Unpaid Balance	$334.72
Current Electric Charges	$197.74
Electric Adjustments	-39.42
Current Gas Charges	69.89
Total Amount Due by	**$562.93**

Current charges include discounts of $169.58 for CARE and CA Climate Credit.

Monthly Billing History

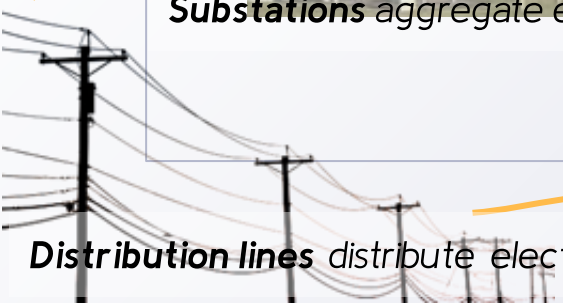
Daily Usage Comparison

Visit www.pge.com/MyEnergy for a detailed bill comparison

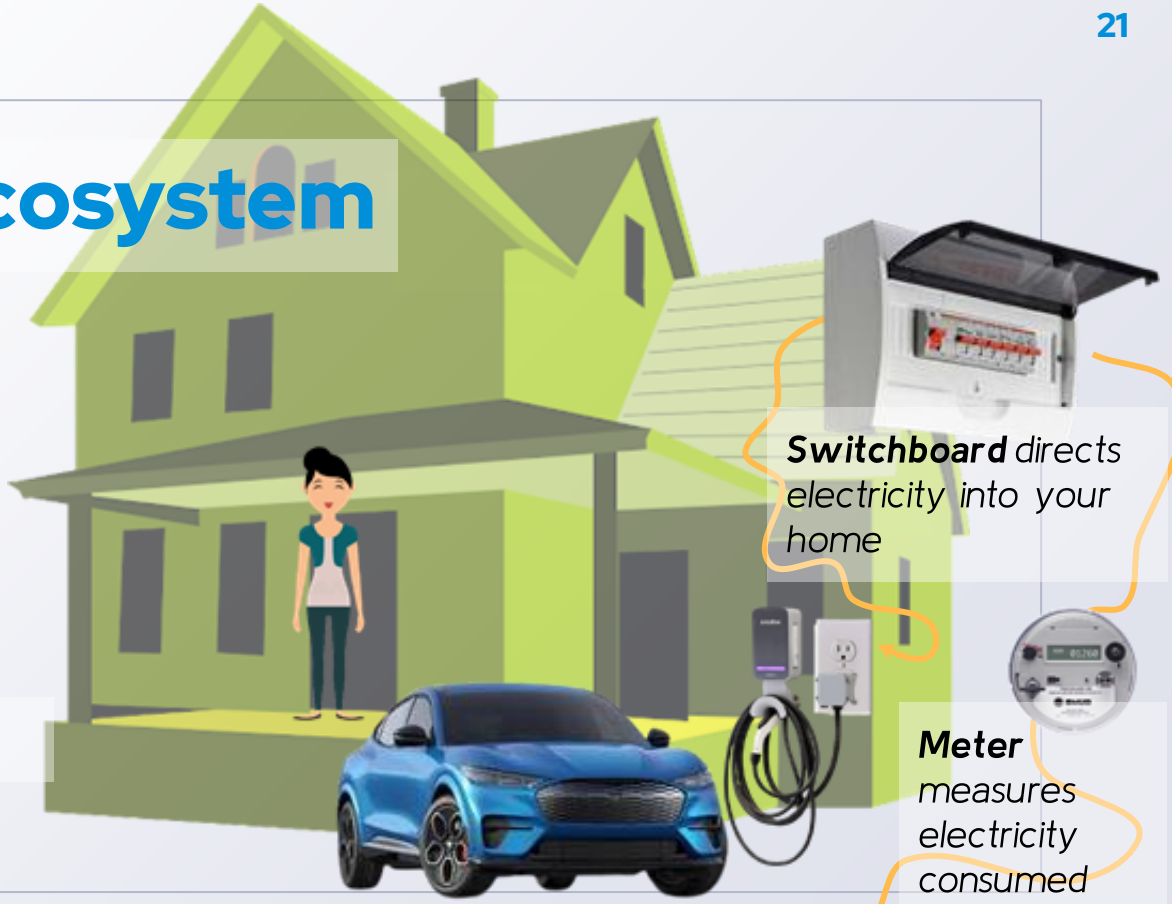
EV Charging Ecosystem

Electricity *is generated*

Substations *aggregate electricity*



Distribution lines *distribute electricity locally*



Energy provider *delivers your home electricity*

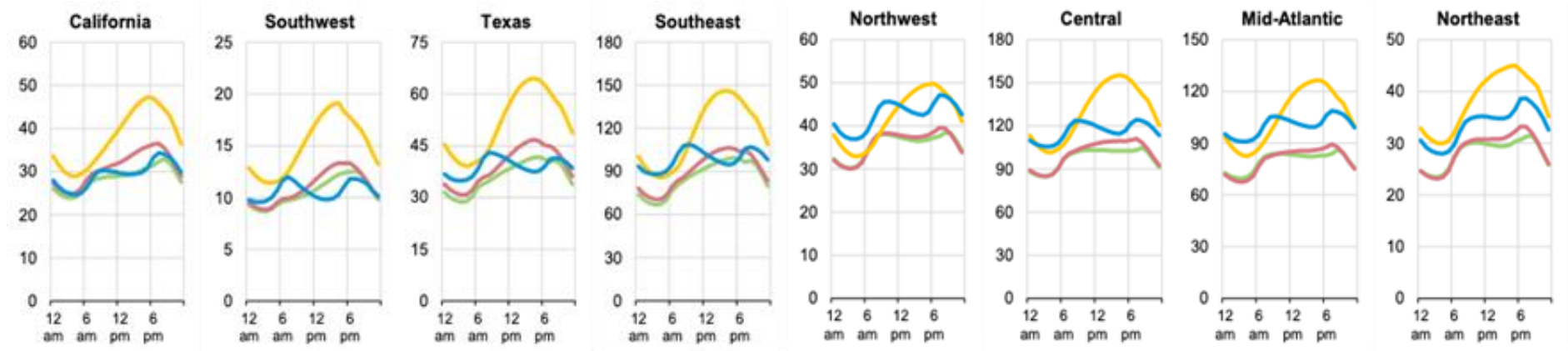
Switchboard *directs electricity into your home*

Meter *measures electricity consumed*

Average hourly electricity load during typical day by region, selected months

million kilowatthours

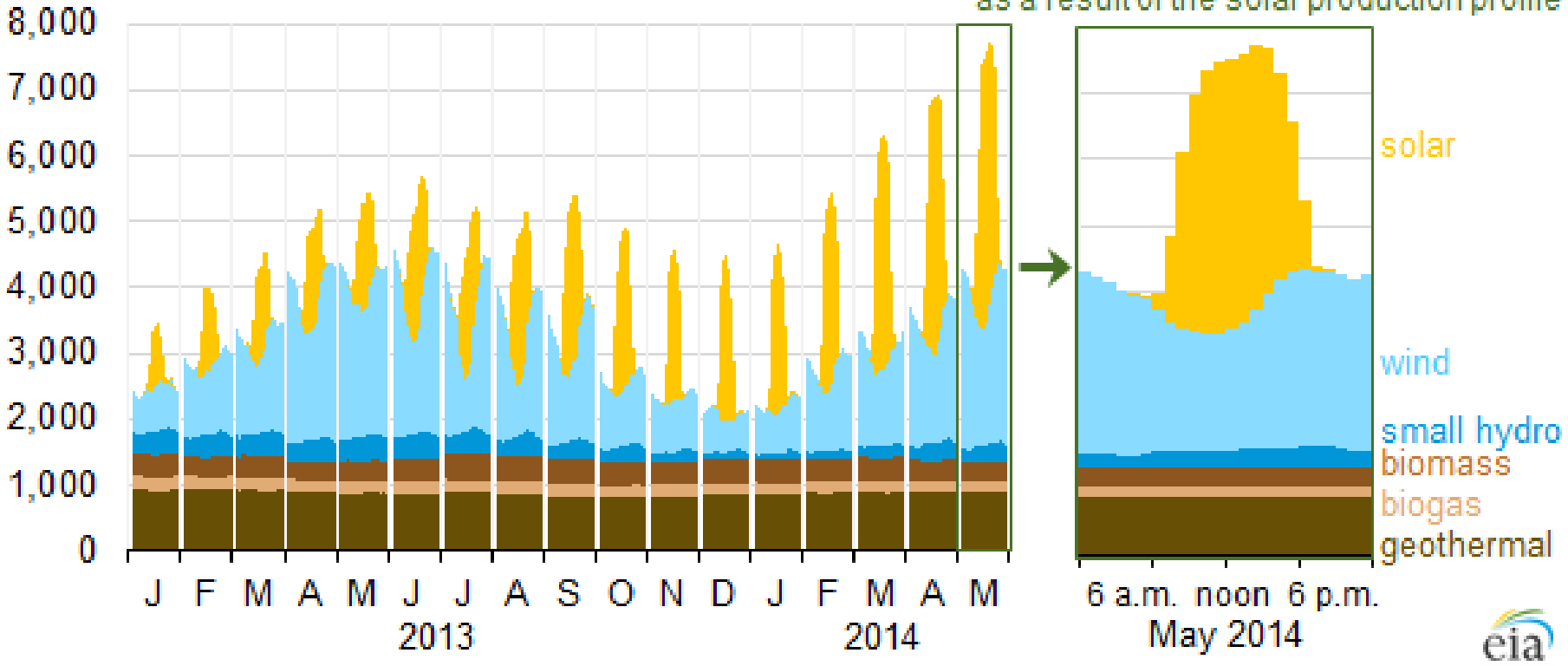
January
April
July
October



Average hourly California renewable electricity production profile by month

megawatts

Total renewable production generally peaks midday as a result of the solar production profile



Utilities Companies Don't Want an Unbalanced Grid.

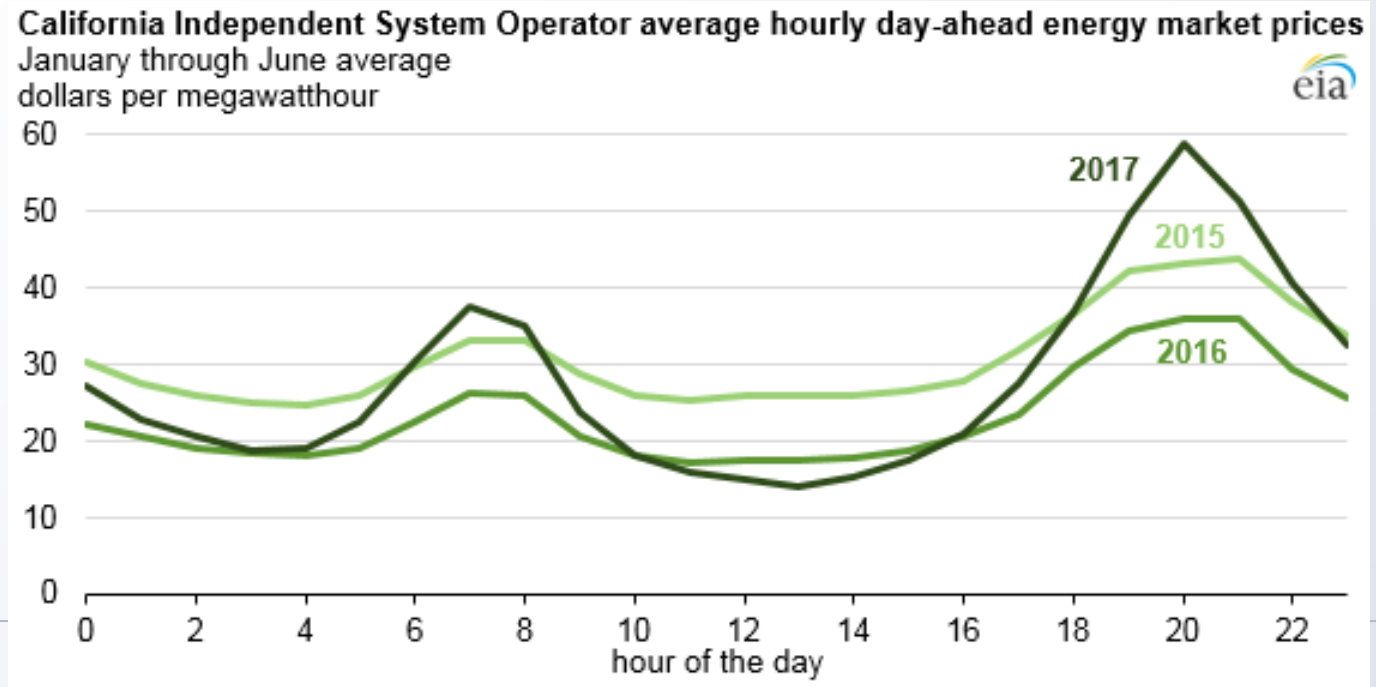
Why?

- Power plants are designed for a certain frequency.
- Fluctuating supply/demand electricity impacts frequency.
- Incorrect frequencies can collapse the grid.

The challenge for utilities companies:

How do we keep the grid balanced?

Day-Ahead Energy Markets Manipulate Demand



Utilities Pay Demand Response Companies To Manage Home Electricity

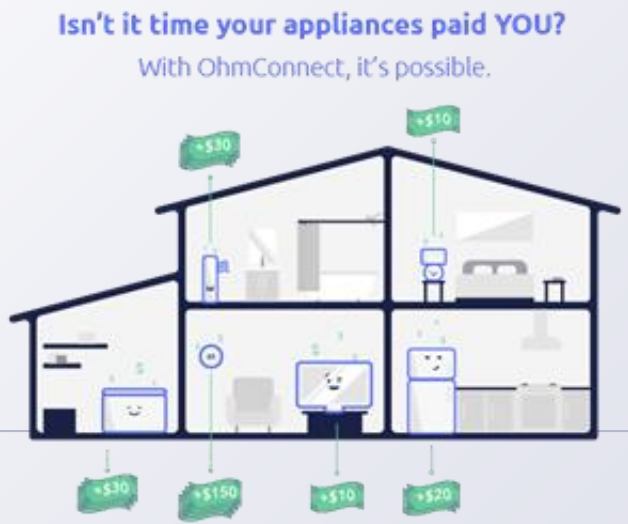
PG&E: "There's too much demand and too little electricity available right now. We need to **get people off the grid ASAP**."

Demand response company: "**Pay us** and we'll make our customers turn off their appliances."

PG&E: "Awesome! Win-win."

Utilities Pay Demand Response Companies To Manage Home Electricity

Example: OhmConnect



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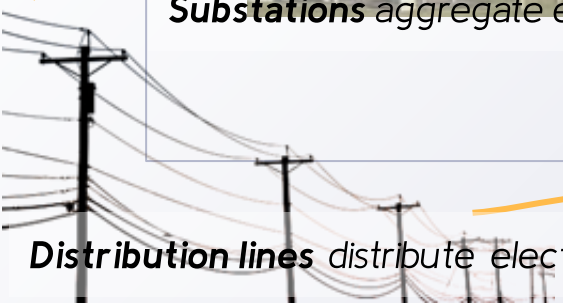

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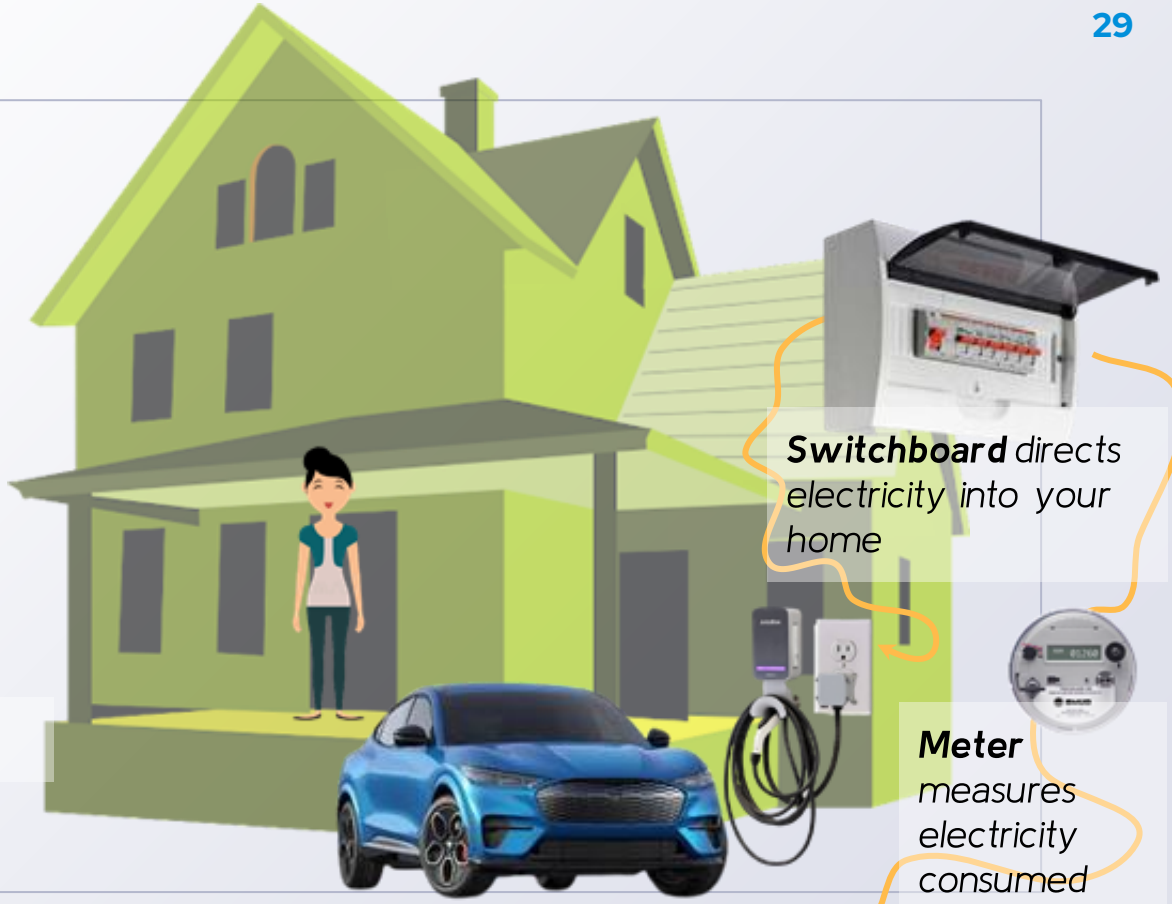
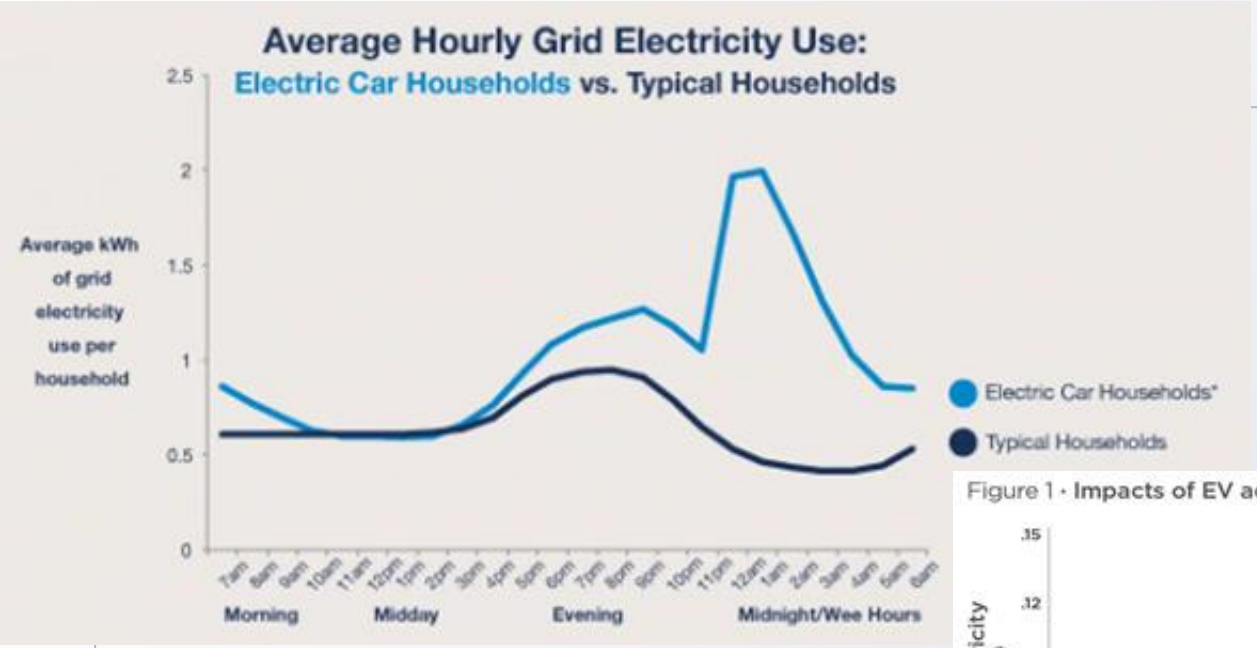


Energy provider *delivers your home electricity*

Switchboard *directs electricity into your home*

Meter *measures electricity consumed*


Average Hourly Grid Electricity Use:
Electric Car Households vs. Typical Households
Average kWh of grid electricity use per household
2.5
2
1.5
1
0.5
0
Morning
Midday
Evening
Midnight/Wee Hours
Electric Car Households*
Typical Households

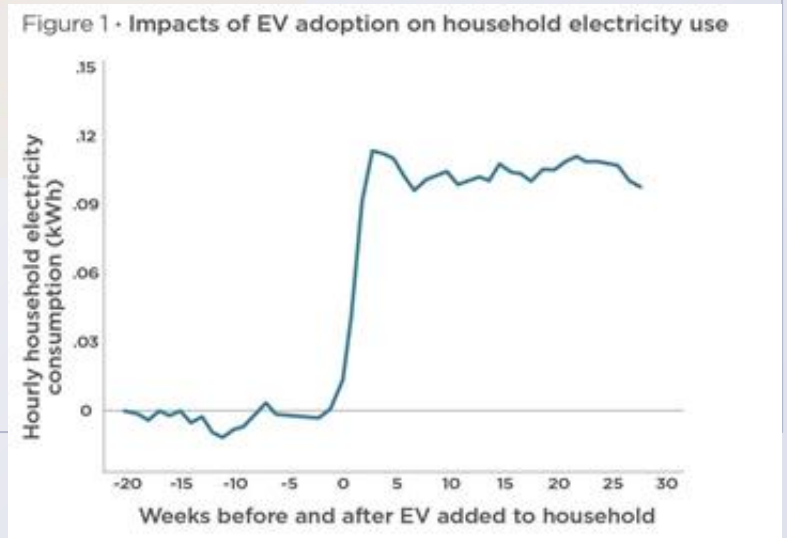


Figure 1 · Impacts of EV adoption on household electricity use
Hourly household electricity consumption (kWh)
.15
.12
.09
.06
.03
0
-20
-15
-10
-5
0
5
10
15
20
25
30
Weeks before and after EV added to household

A big concern for utilities companies:

How do we keep the grid balanced with an influx of EVs?

We're interested in how EV charging can **make the grid more– not less– balanced**.

Ford SmartGrid Rewards

Detroit Pilot

Introducing Ford SmartGrid Rewards

Ford SmartGrid Rewards work with utilities to help Ford drivers unlock new value and clean energy. As a Ford electric vehicle customer, you'll get paid incentives for enrolling to automatically pause or shift your charging schedule to support more renewable energy and the efficiency of the energy grid, without impacting your daily schedule.

The Plus

The DTE Smart Charge pilot program helps electric vehicle drivers get rewarded for supporting stability of the energy grid. DTE Energy and Ford SmartGrid Rewards will work together to either pause your vehicle's charging when the...

Show more

The Process

It's all fairly simple and you don't have to do much at all. DTE Energy will notify Ford when they anticipate the energy grid will be strained and request to either pause charging for a short period or, if there is an excess of energy, request your car to start...

Show more

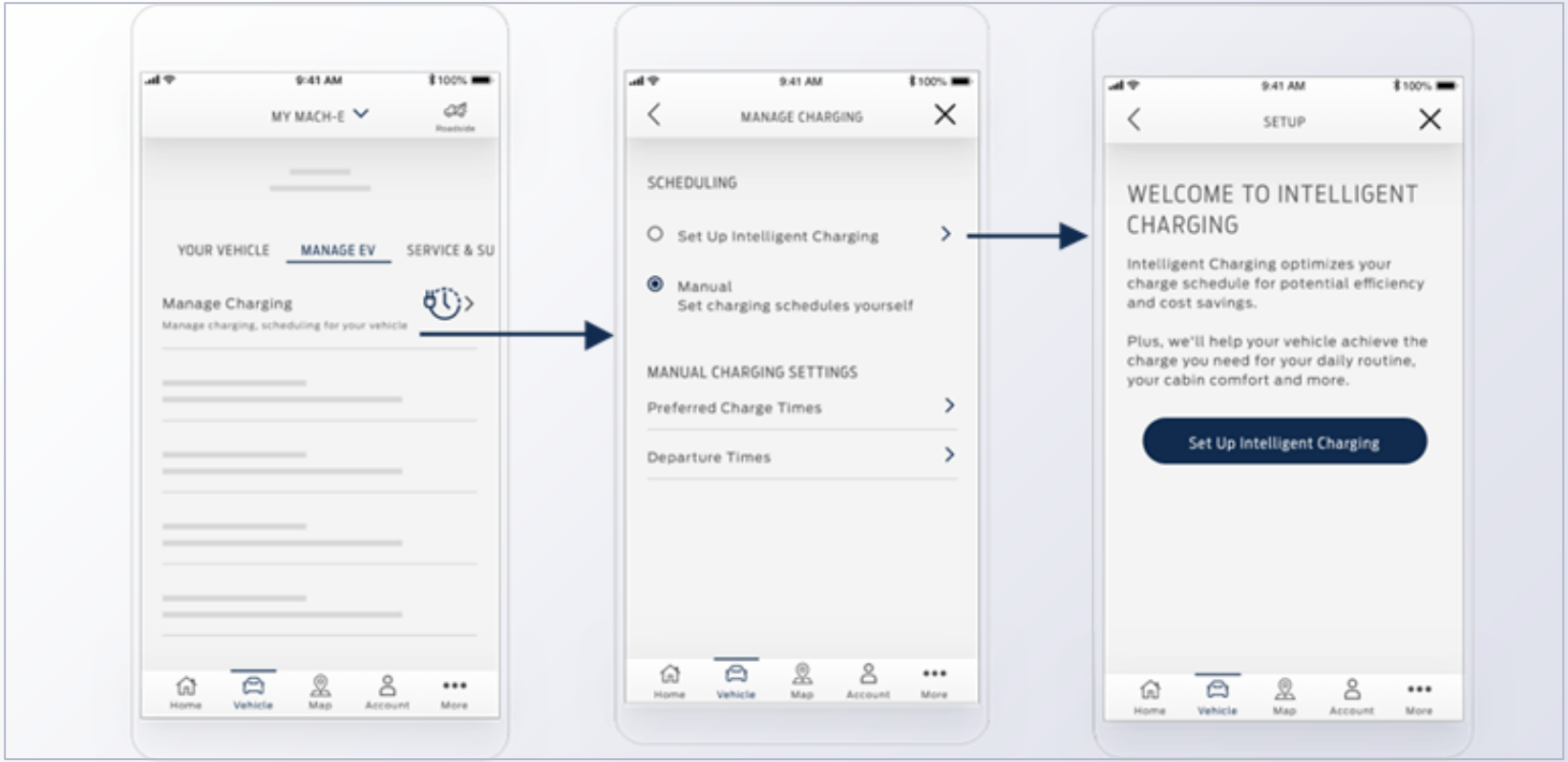
The Provider

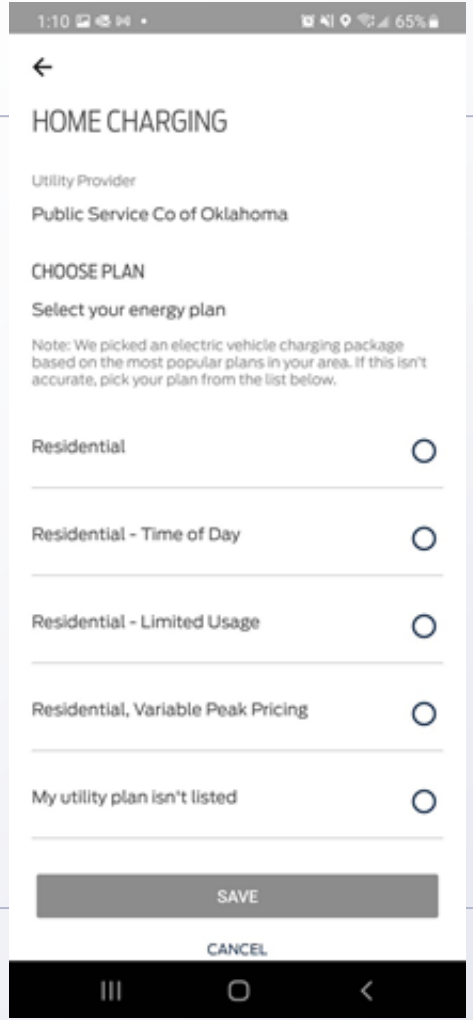
DTE Energy is a Detroit-based diversified energy company involved in the development and management of energy-related businesses and services nationwide. As an environmental leader, DTE utility operations will reduce carbon dioxide and...

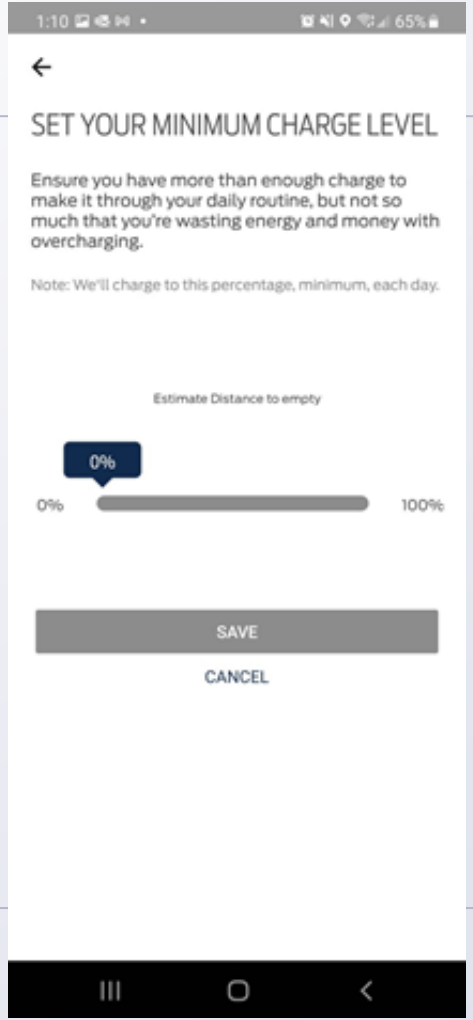
Show more

Ford Intelligent Charging

Mach-E Early Release Feature


9:41 AM
100%
MY MACH-E
YOUR VEHICLE
MANAGE EV
SERVICE & SU
Manage Charging
Manage charging, scheduling for your vehicle
Home
Vehicle
Map
Account
More
MANAGE CHARGING
SCHEDULING
Set Up Intelligent Charging
Manual
Set charging schedules yourself
MANUAL CHARGING SETTINGS
Preferred Charge Times
Departure Times
SETUP
WELCOME TO INTELLIGENT CHARGING
Intelligent Charging optimizes your charge schedule for potential efficiency and cost savings.
Plus, we'll help your vehicle achieve the charge you need for your daily routine, your cabin comfort and more.
Set Up Intelligent Charging


1:10
65%
HOME CHARGING
Utility Provider
Public Service Co of Oklahoma
CHOOSE PLAN
Select your energy plan
Note: We picked an electric vehicle charging package based on the most popular plans in your area. If this isn't accurate, pick your plan from the list below.
Residential
Residential - Time of Day
Residential - Limited Usage
Residential, Variable Peak Pricing
My utility plan isn't listed
SAVE
CANCEL


1:10
65%
SET YOUR MINIMUM CHARGE LEVEL
Ensure you have more than enough charge to make it through your daily routine, but not so much that you're wasting energy and money with overcharging.
Note: We'll charge to this percentage, minimum, each day.
Estimate Distance to empty
0%
0%
100%
SAVE
CANCEL

> Maybe this feature really can optimize battery life. Or maybe you can accomplish the same thing by not charging to 100%? I don't know.
>
> – Mach-E owner

Hypothesis: If the incentives for participating in SmartGrid services were aligned with users' motivations, more users would choose to participate.

Potential motivations

- Cost savings
- Renewable usage
- Grid participation
- Battery life
- Ongoing rewards

Our MVP

User motivations ⟷ Proposed benefits

Customer:

Utility companies who want to keep the grid online.

User:

Ford EV homeowners who want convenient charging.

Value Proposition for Utilities Companies

Better grid management

- ➔ More visibility
- ➔ More control
- ➔ Ability to manipulate demand
- ➔ Less strain on grid

Value Proposition for EV Owners

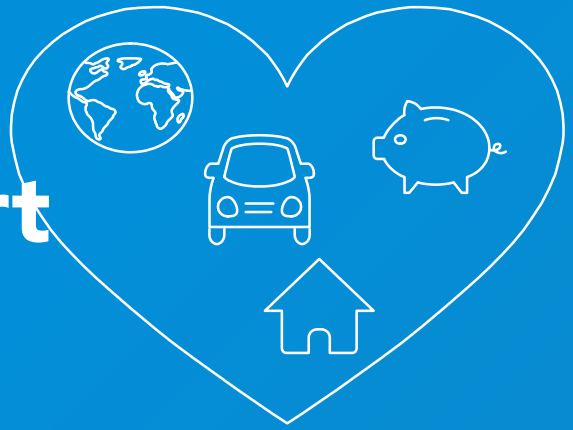
Save money

Reduce your impact on the environment

Optimize your home energy management

Help balance the grid

The Emotional Appeal to EV Owners



+ **Feel sustainable**
+ **Feel financially smart**
+ **Feel proud**
+ **Feel helpful**
+ **Feel more emotionally connected to your car**

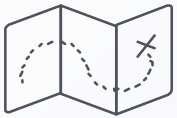
Decision Making Units

- Initiator: person informed/alerted about grid services
- Decider: EV owner
- Influencers: friends, family, neighbors, colleagues
- Purchaser: household purchaser
- Users: drivers and passengers of the EV
- Gatekeepers: ?

Decision Making Process

1. Introduction
    a. Receive email asking to opt-in to the SmartGrid program
    b. Go to the Ford SmartGrid website
2. Education and exploration
    a. Search the internet
    b. Ask fellow Ford EV owners you know about this program
    c. Talk to family and friends
3. Enrollment
    a. Go to your local utility's SmartGrid landing page
    b. Set up account

Barriers to Adoption of EV+Grid Programs For Our Users



Effort

Unintuitive UX/UI

Distrust

Lack of awareness + understanding

Agenda

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2. **Market Investigation**
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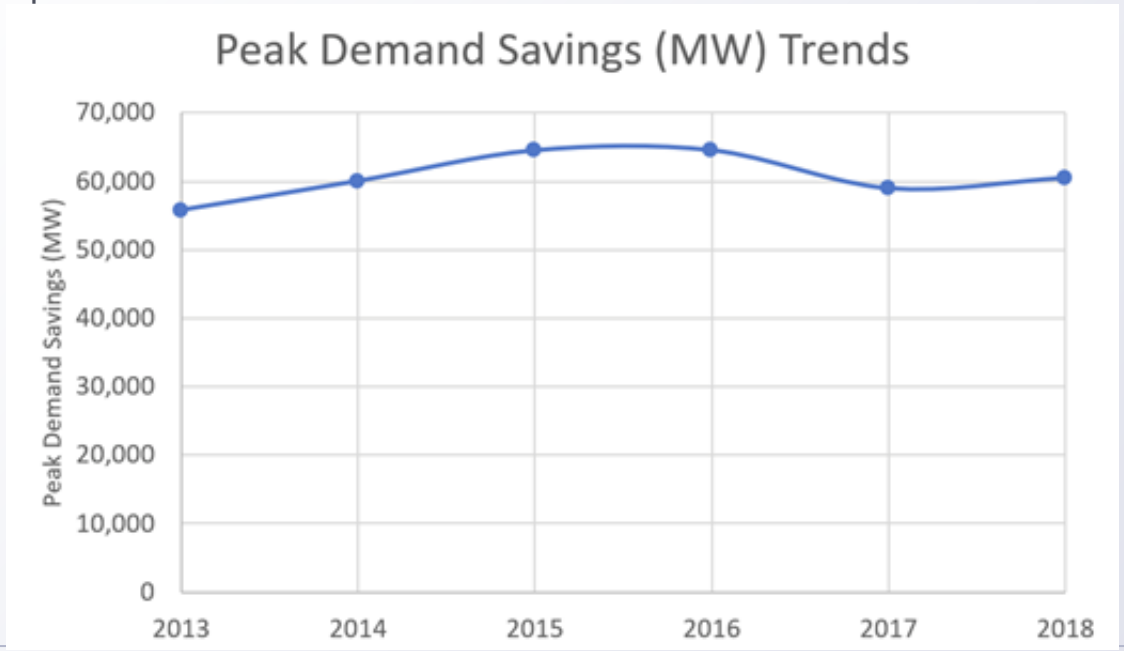
US Demand Response Trends

The Federal Energy Regulatory Commission (FERC) provides yearly assessments on demand response



Source: https://www.ferc.gov/industries-data/electric/power-sales-and-markets/demand-response/reports-demand-response-and

How is revenue generated from demand response?

- Order No. 745 from FERC
  - required each RTO and ISO to pay a demand response resource the market price for energy

In other words, the amount of energy you reduce during a demand response event is directly compensated at market price

Demand Response Value

- Compensation of demand response dependent on operating market
- KW-year is energy curtailed during demand response event
- Estimate to be approximately **$55 / kw-yr** (data average)

Program	$ / kW-yr
PG&E Capacity Bidding	62
SCE Capacity Bidding	66-75
PJM	~20-50 (in 2018)
Hawaiian Electric	60-120+
MISO	~25
ISO-NE	~35-70

Source: https://www.gridfabric.io/blog/introduction-to-demand-response

Total Available Market Estimate

- Given peak demand response for the year and yearly price average, we can estimate yearly revenue

Revenue = Yearly Peak Demand Savings (**FERC Data**) **x** Average Yearly Price (**$55/kw-yr**)

Total Available Market Estimate

~ $ 3.2 billion potential yearly revenue in market

This is a big number, but realistically only a small portion of this market will be available to demand response aggregators

Utilities and RTO/ISO also participate in demand response market, so they take a significant portion of the revenue in the market they control

Market Segmentation – Energy Suppliers

Wholesale Suppliers

Provide the energy for the energy grid, selling it to retail suppliers (CAISO + ERCOT)

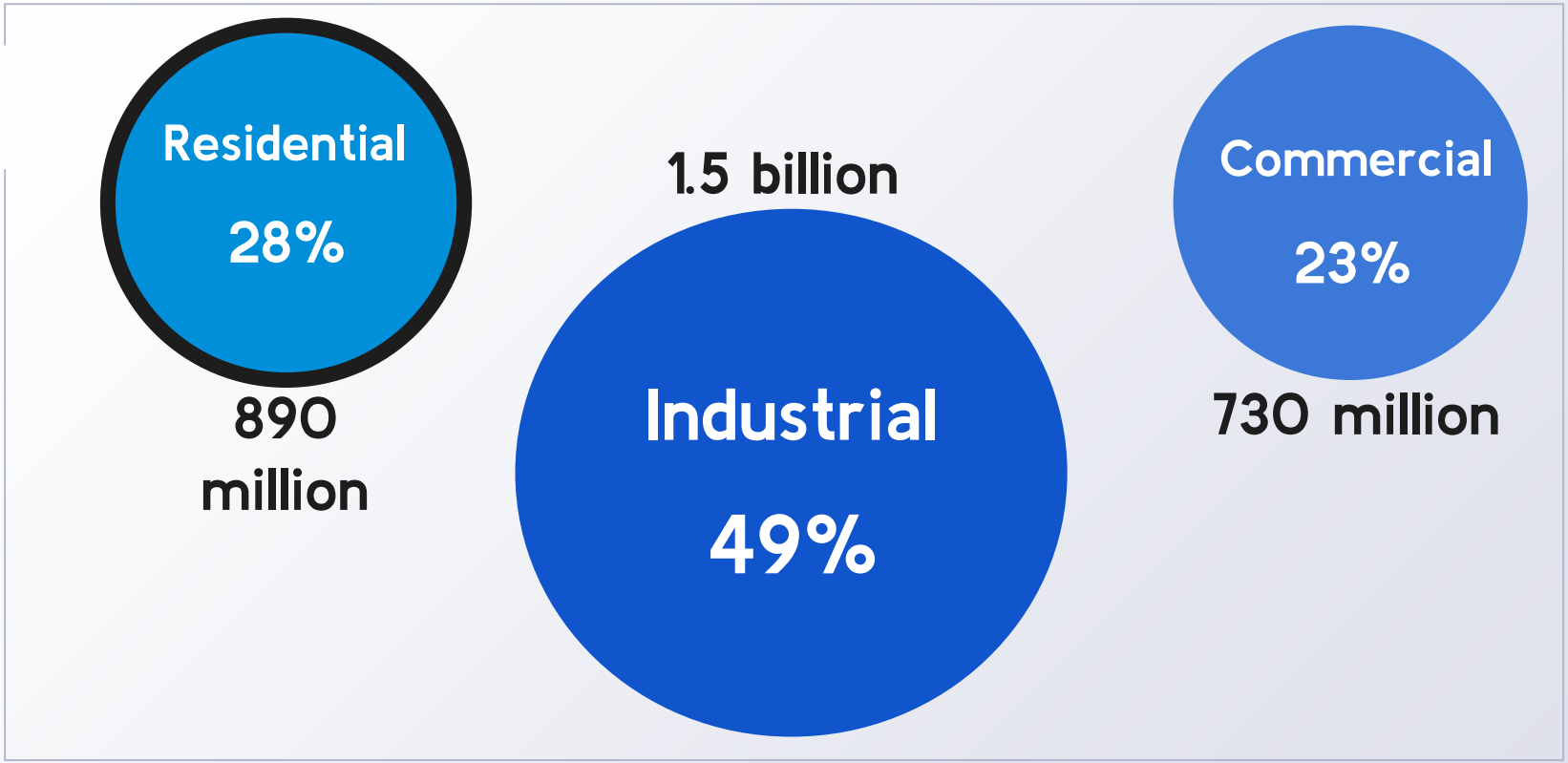
Retail Suppliers

Purchase energy from the wholesale suppliers, and provides it to end users in residences

Demand Response Aggregators

Work with both wholesale and retail suppliers to decrease energy consumption during peak events

Market Segmentation – Energy Users



Driving Forces

Governmental Regulations

Collaboration from local utility companies

Penetration of EVs

Served Available Market Rate

- Project Ford will have 20-30% EV production by 2025
  - Estimate EVs Sold = Total Production **x** 20-30%
- From EV's sold, assume a 10% adoption rate for demand response system
  - Big assumption, and goal of product is to increase this number
- From user data online, 10-20% charging overlap with demand response events

Energy saved is directly equated to revenue

Served Available Market Rate – Calculation

$2.4 – 7.3 million in yearly revenue

Total Cars Ford Produced	Percent EV cars	Percent Retention	Percent Charging Overlap	Average Miles Driven a Year	MW-Hr per Mile	Total MW-Hr per Year	Average cost for MW-Hr	Yearly Revenue
4438000	0.2	0.1	0.1	13500	0.000678	81242.028	30	$ 2,437,260.84
4438000	0.3	0.1	0.2	13500	0.000678	243726.084	30	$ 7,311,782.52

Sources: https://www.statista.com/outlook/mmo/passenger-cars/ford/worldwide
https://freewiretech.com/difference-between-ev-charging-levels/
https://www.eia.gov/todayinenergy/detail.php?id=46396

Agenda

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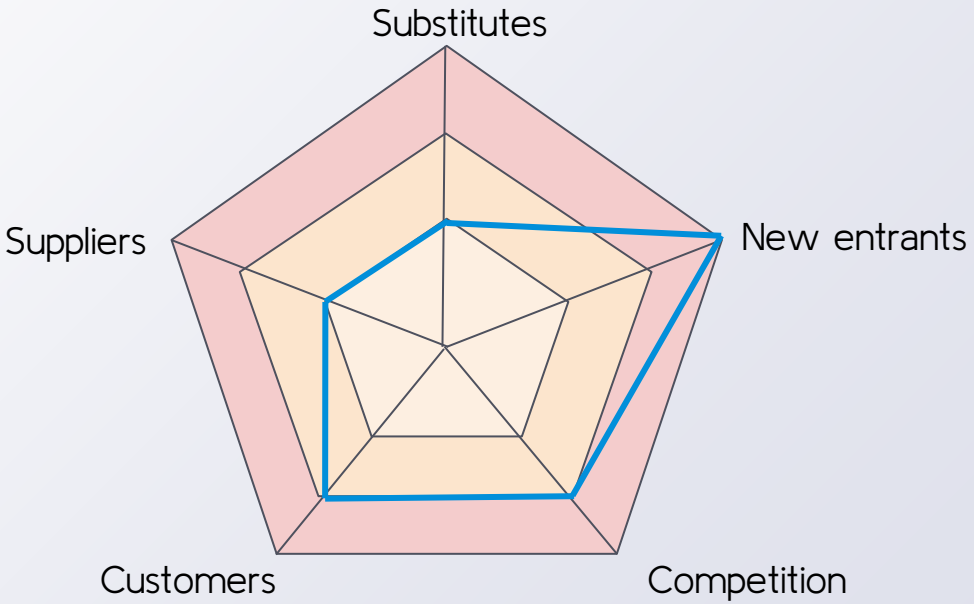
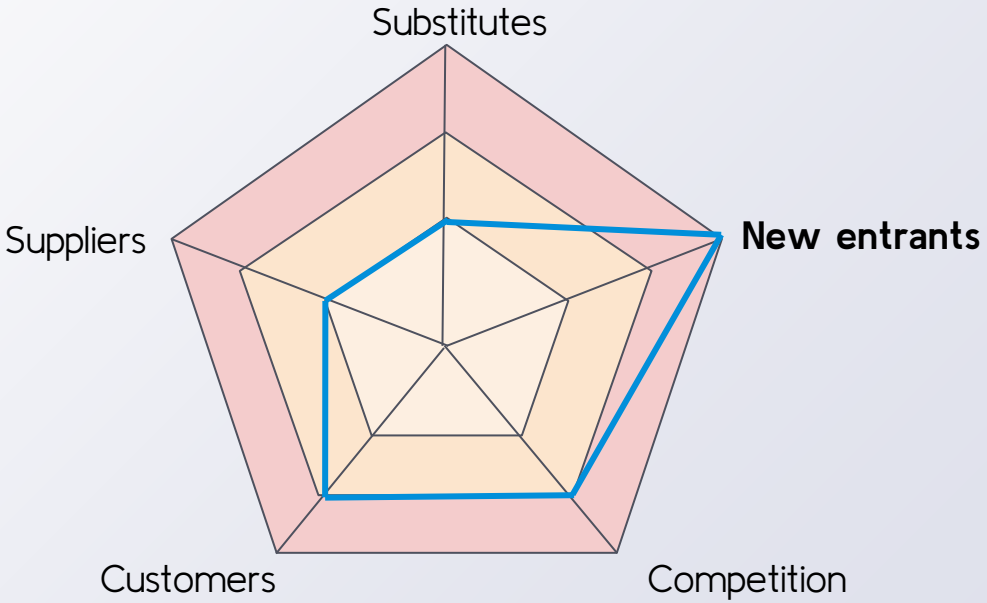
Competitive Forces

- New Entrants – High
- Customers – Medium
- Suppliers – Low
- Substitutes – Low
- Competition – Medium



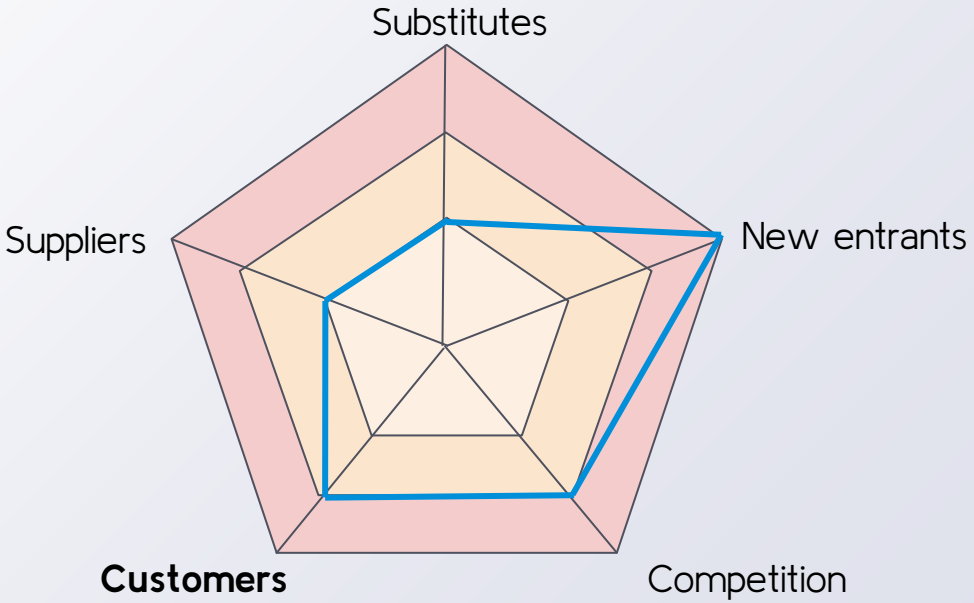
Competitive Forces

- **New Entrants – High**
  - Barriers to entry is low
  - At scale acceptance is difficult



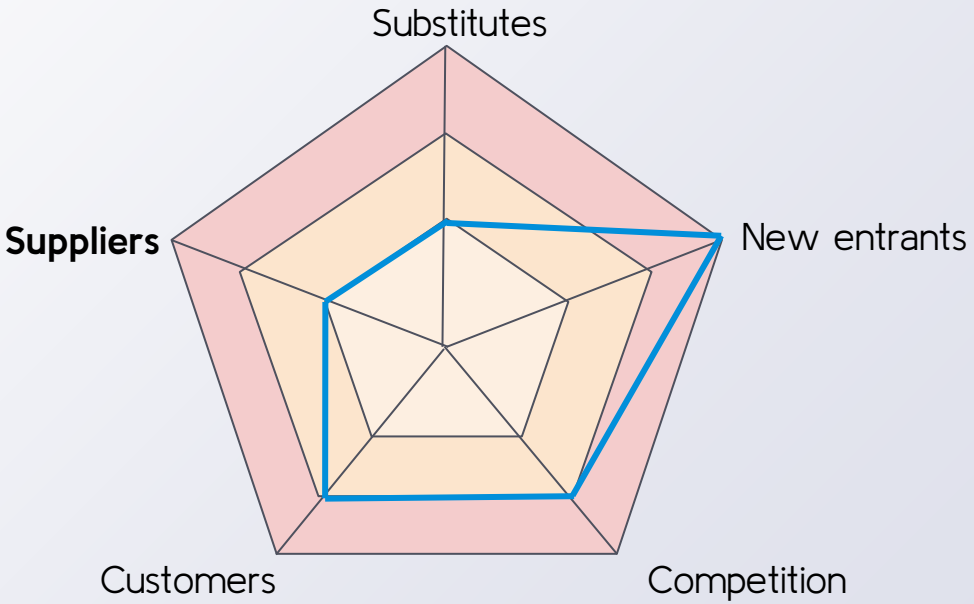
Competitive Forces

- New Entrants – High
- **Customers – Medium**
  - Low switching costs
  - Low switching options



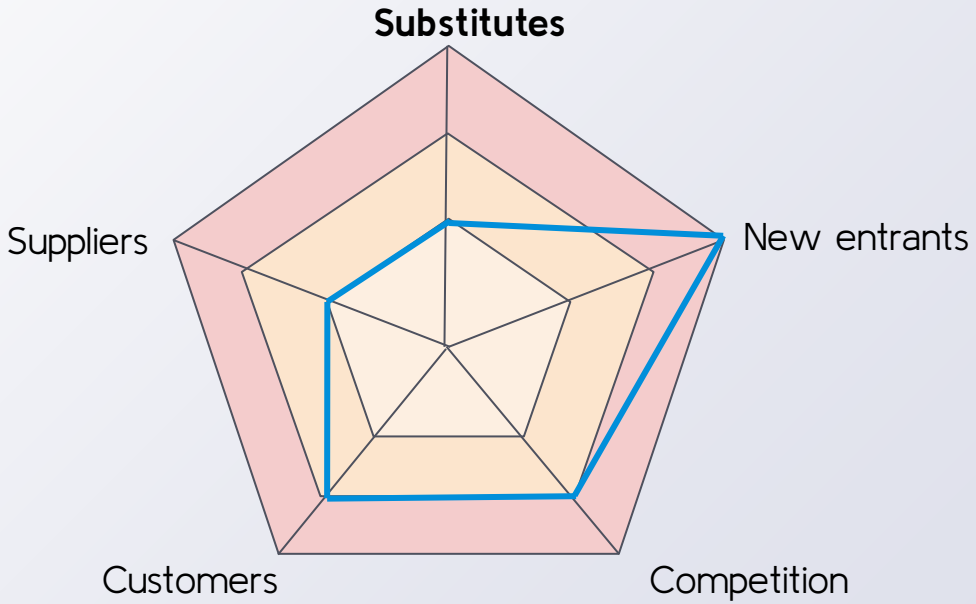
Competitive Forces

- New Entrants – High
- Customers – Medium
- **Suppliers – Low**
  - Charger suppliers
  - Charger part suppliers



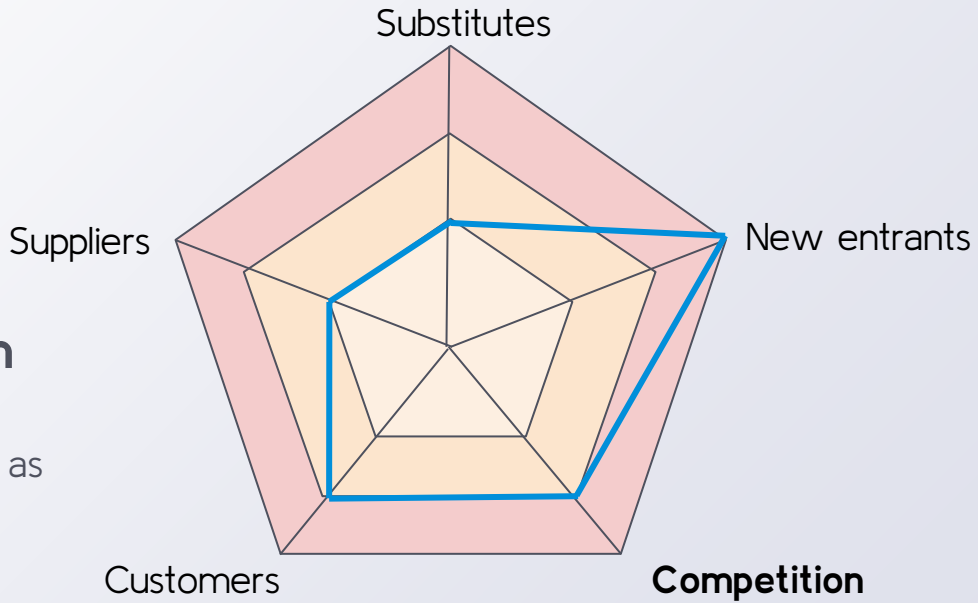
Competitive Forces

- New Entrants – High
- Customers – Medium
- Suppliers – Low
- **Substitutes – Low**
  - Alternate energy aggregators
  - Non-participation (public charging, charging at work)



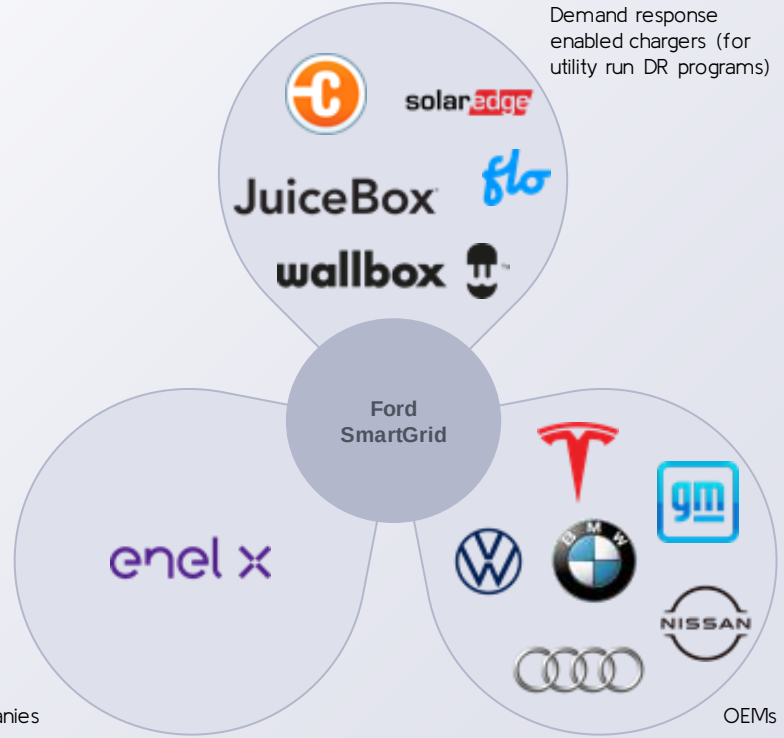
Competitive Forces

- New Entrants – High
- Customers – Medium
- Suppliers – Low
- Substitutes – Low
- **Competition – Medium**
  - New market opportunity
  - Home charging companies as potential competition



Competitor Analysis

- Demand Response Enabled Chargers & Companies
- OEMs



Competitor Analysis

Demand Response Enabled Chargers & Companies

- Chargers compatible with utility company demand response programs
  - ChargePoint
  - JuiceBox
  - SolarEdge
  - Flo
  - Wallbox
- Demand response companies
  - Enel X

Competitor Analysis

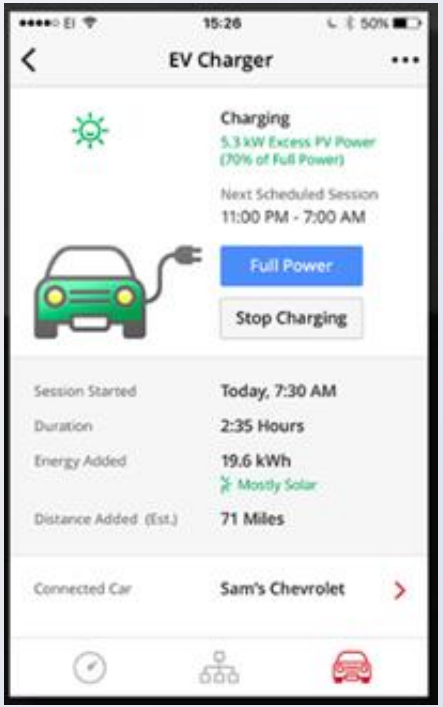
ChargePoint

- ChargePoint Flex Level 2 Home Charger
- ChargePoint app for charge management
  - Track charging
  - Schedule charging
  - Connect to smart devices

Competitor Analysis

SolarEdge

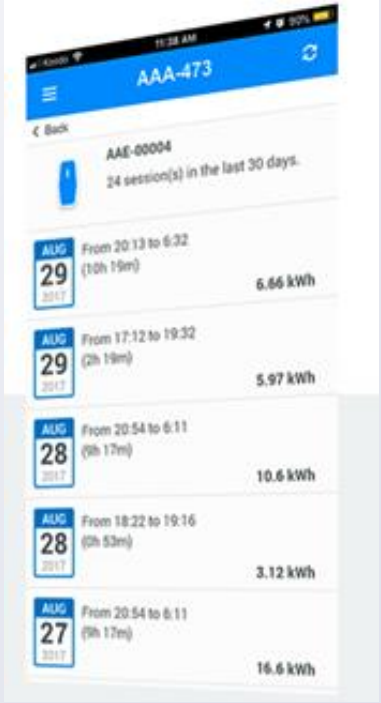
- SolarEdge Smart EV Charger
- Integrates with home solar system
- Mobile app for charge management
  - Wi-Fi enabled
  - Track charging
  - Schedule charging



Competitor Analysis

Flo

- Flo Home X5
- Manage through mobile app
  - Schedule charging
  - Track charging



Competitor Analysis

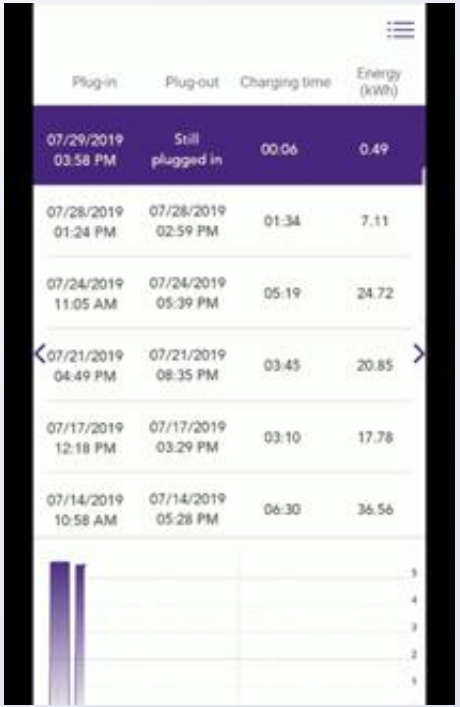
Wallbox

- Pulsar Plus and Quasar home chargers
- First home bi-directional charger
- Manage through mobile app
  - Schedule charging
  - Monitor consumption

Competitor Analysis

JuiceBox

- JuiceBox Level 2 Home Charger
- Part of Enel X, a global energy company
- Mobile app for charge management
  - Track charging
  - Schedule charging
  - Connect to smart devices



Competitor Analysis

Enel X

- JuicePoints program
- Connect with JuiceNet app
  - Automatically charges with cheaper and cleaner power
  - Earn JuicePoints for allowing Enel X to optimize charging schedule
  - Redeem for cash through PayPal

Competitor Analysis

OEMs

- Demand response pilot tests & energy aggregators
  - Tesla
  - GM
  - VW
  - Nissan
  - Audi
  - BMW

Competitor Analysis

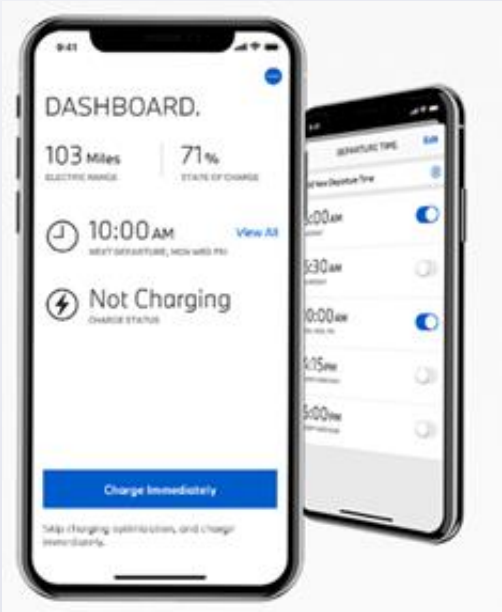
GM

- Chevrolet is also participating in DTE pilot
- Must have OnStar or Chevy Connected Services plan to participate

Competitor Analysis

BMW

- ChargeForward smart charging program
  - Partnerships with utility companies
  - Monitor through ChargeForward app



Competitor Analysis

VW

- Home energy management hardware
- Cars on MED platform to have bi-directional charging by 2022
- Could compete with energy companies

Competitor Analysis

Audi

- Home energy storage hardware
- Focus on bi-directional charging
  - V2G and V2H
- Tested prototype E-Tron Sportback Crossover with bi-directional charging

Competitor Analysis

Nissan

- Bi-directional charging capability
  - V2H and V2G
- Home energy storage hardware
  - Offered in Japan & tested in other markets
- Collaborated with energy companies

Competitor Analysis

Tesla

- Home energy hardware
- ConnectedSolutions program
  - VPP with Powerwall
  - Partnership with utility company in Northeast
- VPP Beta in California
  - Partnership with various utility companies

Competitor Analysis

Takeaways:

- There are other home chargers which can participate in demand response
  - Fragmented
- Other OEMs are piloting demand response and exploring energy aggregation

Agenda

1. Customer and Job to Be Done
2. Market Investigation
3. Competitive Analysis
4. **Technical Feasibility**
5. Risk Identification
6. Next Steps

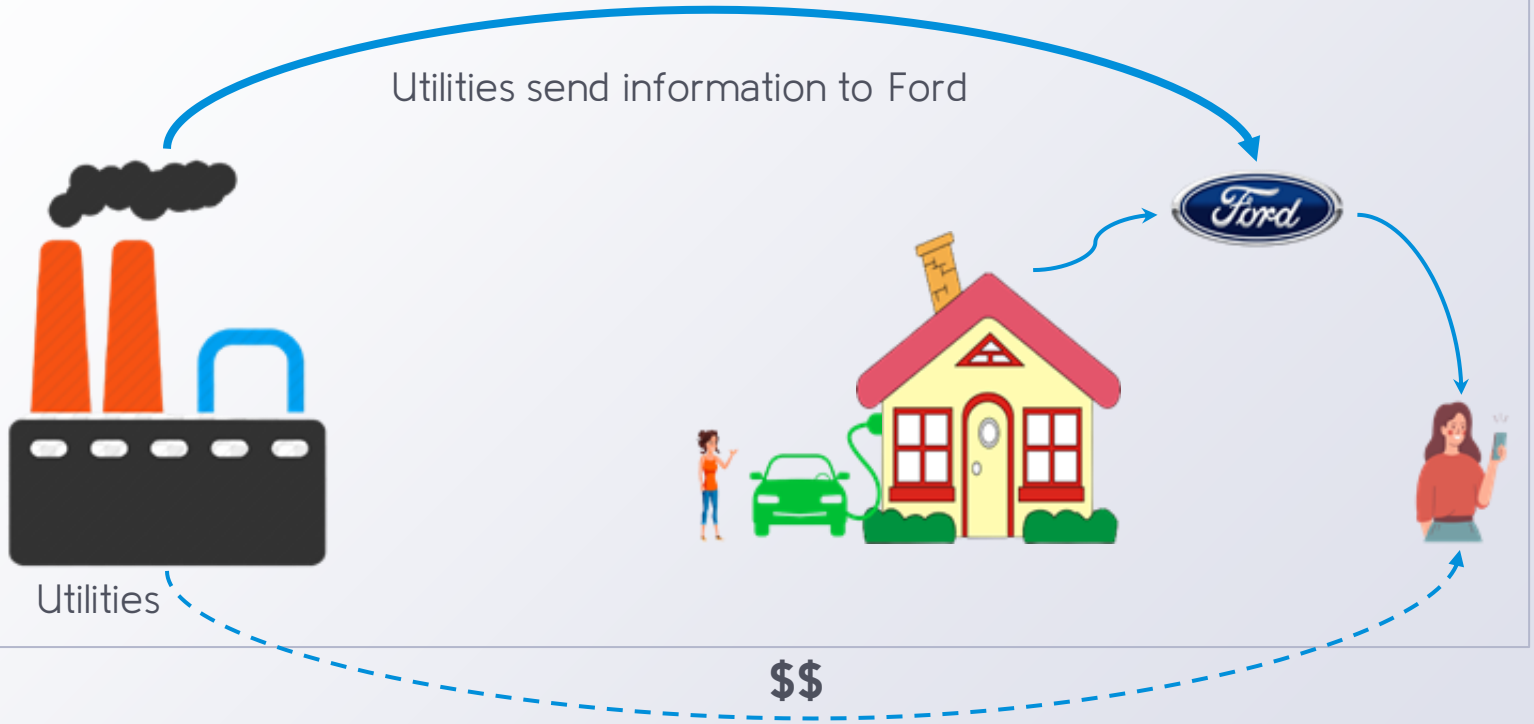
User Journey

Ford manages charging schedule

Plug-in your EV

User notified + $$

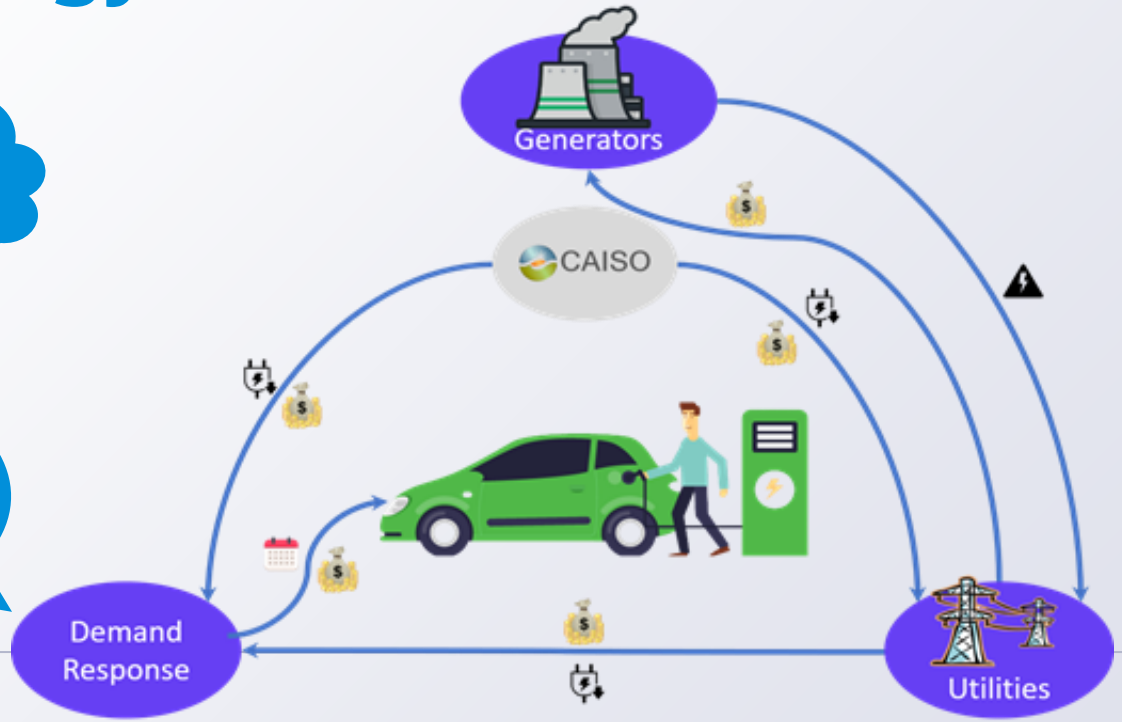
Behind the Scenes



Technology Overview – Grid + EVs

Grid Services

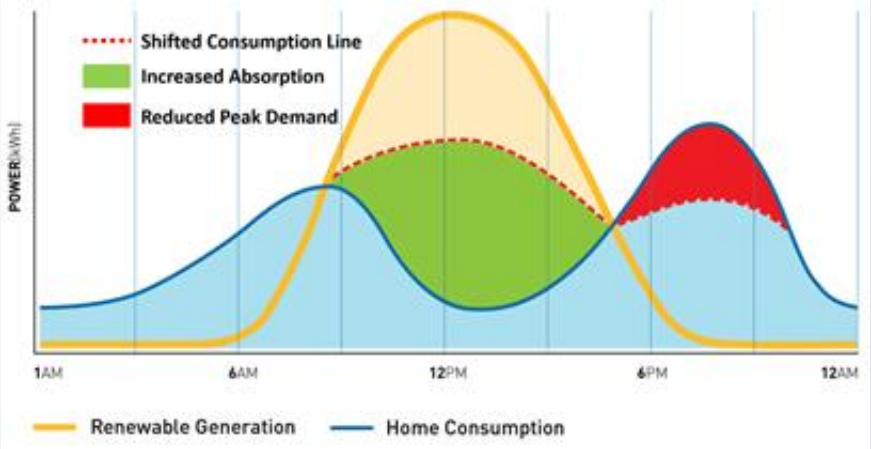
Partner with them OR become them!



Technology Overview – Grid + EVs

Energy Arbitrage

Dynamic Pricing



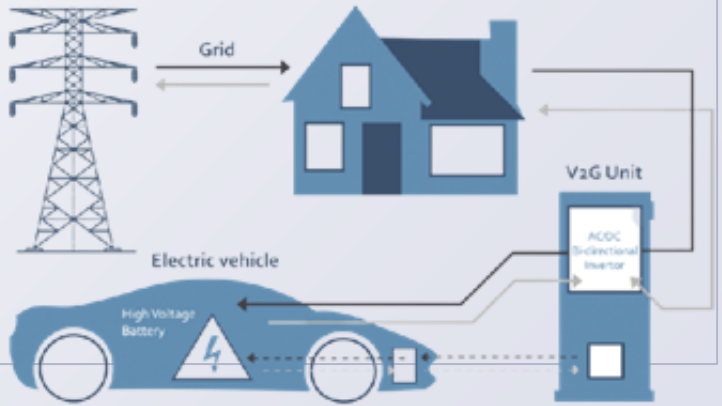
Technology Overview – Charger

The Future – V2H / V2G

- Power various appliances at home

  Vehicle to House

- Volkswagen: mass production of EVs with V2G by next year



Technology Overview – The APP

- Grand Unification = Current Services + SmartGrid + Intelligent Charging
- The integration should be **really** seamless
- Design should be intuitive
- Future of the **user experience** that we aim:
  - motivation → benefits
  - high overlap with the app

Cost Estimate for a unified, user-centric FordPass app UX

Projecting a 9 month development timeline

- **2 Frontend App Developers**
- **2 Backend Developers**
- **2 UI Design Expert**
- **1 Sales + Business**

We estimate a cost of **~$550k**

Note that Ford currently has a ~30 person team working in the same space

Agenda

1. Customer and Job to Be Done
2. Market Investigation
3. Competitive Analysis
4. Technical Feasibility
5. **Risk Identification**
6. Next Steps

Risk Identification

Risk / Key Dependency

- Integration with utilities
- Complexity of multiple charge management systems
- Functionality with various charger types
- User awareness of benefits
- Grid infrastructure
- Directional charging speed
- Battery health

Mitigation

- Leverage pilot experiences
- Clarity of prioritization of systems to users
- Focus on demand-response eligible and popular chargers
- Test user motivations in pilots
  - Clarity of benefits in onboarding experience

Window of Opportunity

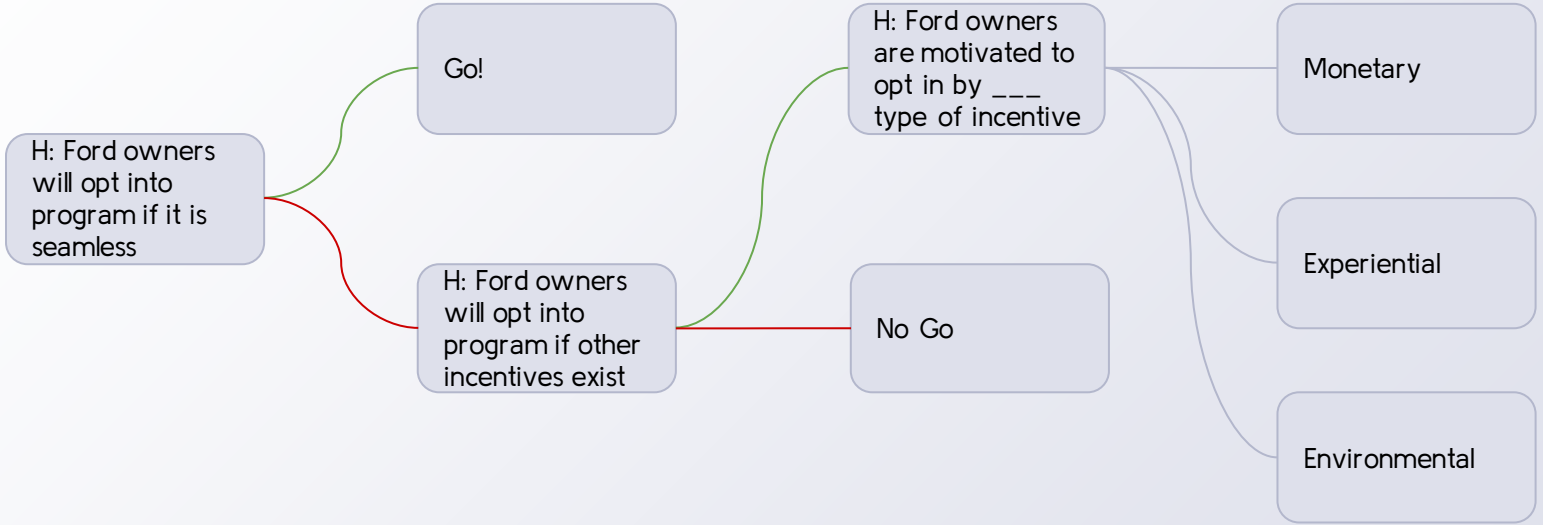
- Increasing EV sales
- Increasing number of outages
- Increasing number of utility companies offering DR programs
- Salience of climate change

In order to capitalize on SmartGrid opportunity, Ford must create a **compelling and seamless user experience**

Ethical Considerations

- Strain of additional EVs on grid
- Privacy concerns with new data collection
- Honesty of environmental impact
  - Don't oversell the impact

Go/No-Go & Hypothesis Testing



Agenda

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Next Steps

- Develop specific and testable MVP
  - Revisit experts *(SmartGrid team, PG&E)*
  - Continue interviewing EV owners *(What motivates them?)*
  - Test hypotheses and iterate

This Is An Awesome Opportunity Space For Ford

- Ford has the **potential** to make **meaningful impact**
  - Ford can **bridge the stakeholders** into a more integrated ecosystem
  - Ford can make **impact** in the advancement of grid balancing
  - Ford can **lead the charge** in EV grid services
- Ford must create a top-notch **user experience**
  - Create a network of **engaged participants** in Ford's programs
  - Boost Ford **customer loyalty** + get **closer** to customers

Q&A