

The Slow Pace of Fast Change

# The Future of Energy Systems

Designed for



Designed by

**Garry Golden**

**Start**

**End**



***In the News***



**Transitions Ahead**



***Next Steps***

# The *Slow Pace* of Fast Change



**20<sup>th</sup> Century Dynamics**

Alternative Futures

Baseline Future

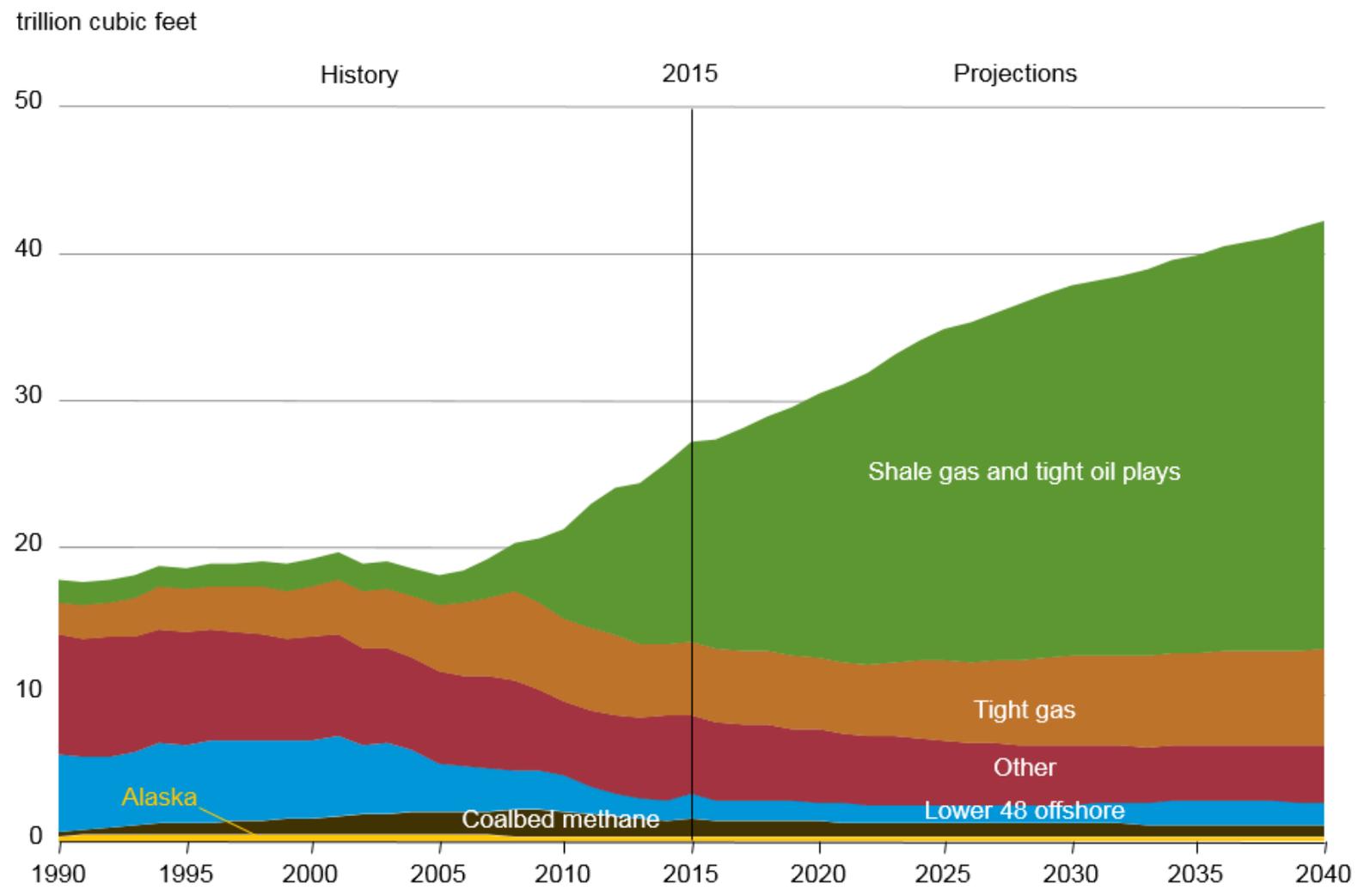
**21<sup>st</sup> Century Dynamics**

Transactive Grid  
Distributed  
? Networks  
? Design for  
? Behavior Change

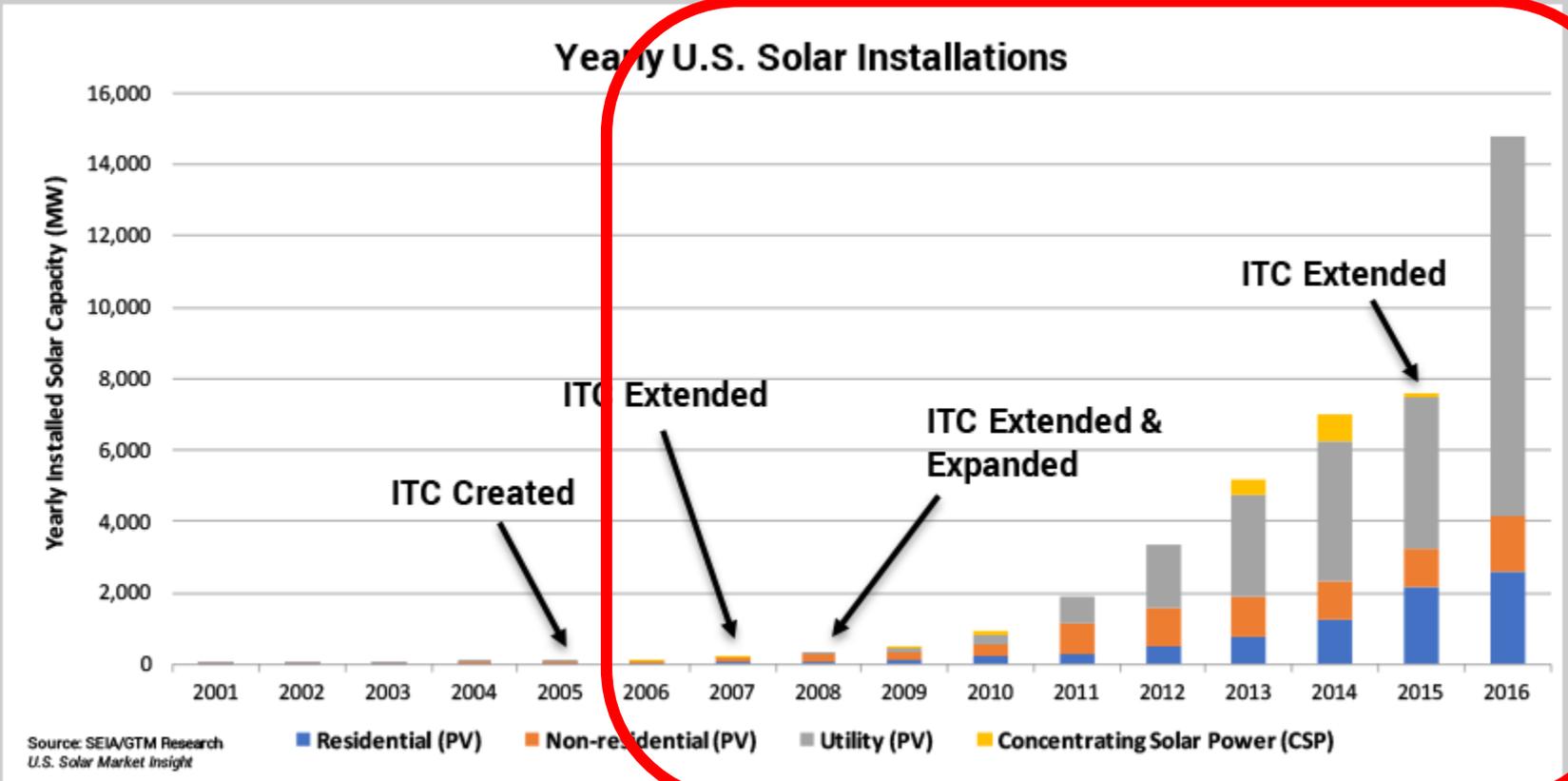
Maintenance,  
Preservation  
& Renewal

# Fuel Source Uncertainties

Figure MT-46. U.S. dry natural gas production by source in the Reference case, 1990–2040



# Policy Uncertainties



# 'Player' Uncertainties

TESLA



Alphabet

amazon

Bloomberg

## Microsoft Is Getting Hungry for Fuel Cells

By **Anna Hirtenstein**  
October 31, 2017, 1:00 AM EDT

Amazon acquires right to buy stake in  
fuel cell maker Plug Power

**Walmart takes a page from  
Amazon, invests in Plug Power**

# Technology Deployment Uncertainties

## Could Coal see a comeback? Cleaner Natgas?

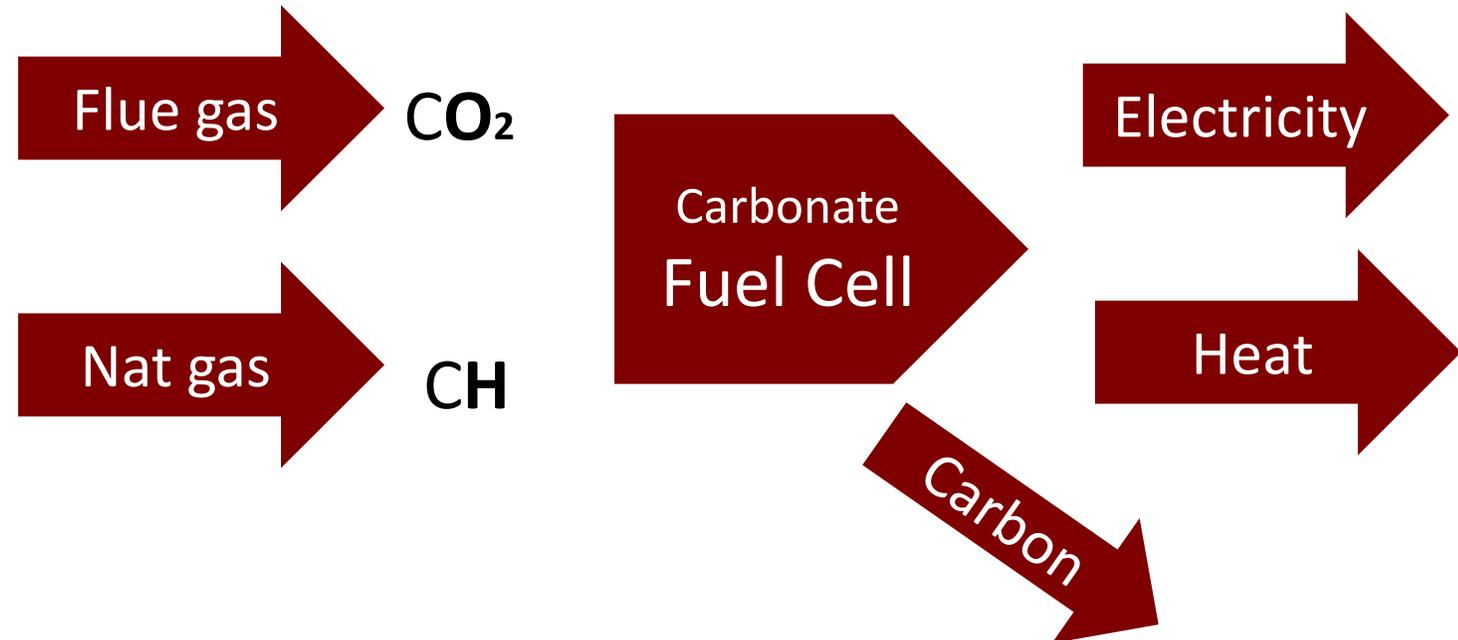
**ExxonMobil**

 FuelCell Energy



<b>Coal plant – no CO<sub>2</sub> capture</b>	<b>500 MW</b>	<b>.06 (\$/kWh)</b>
90% amine capture	400 MW	.11 (\$/kWh)
<b>90% CO<sub>2</sub> capture with fuel cell</b>	<b>900 MW</b>	<b>.08 (\$/kWh)</b>
5% CO <sub>2</sub> capture with fuel cell	522 MW	.06 (\$/kWh)

(Source: Fuelcell Energy & ExxonMobil)



**Every day I make an effort to move toward  
what I do not understand.**

**- Cellist, Yo-Yo Ma**

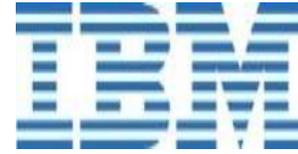
# Four Futures Thinking



**Continued  
Growth**



**Disciplined  
Constrained**



**Transformed**



**Decline  
Collapse**

# Could you Write the Four Futures for NCPA and Your POU?



**Continued  
Growth**



**Disciplined  
Constrained**



**Transformed**



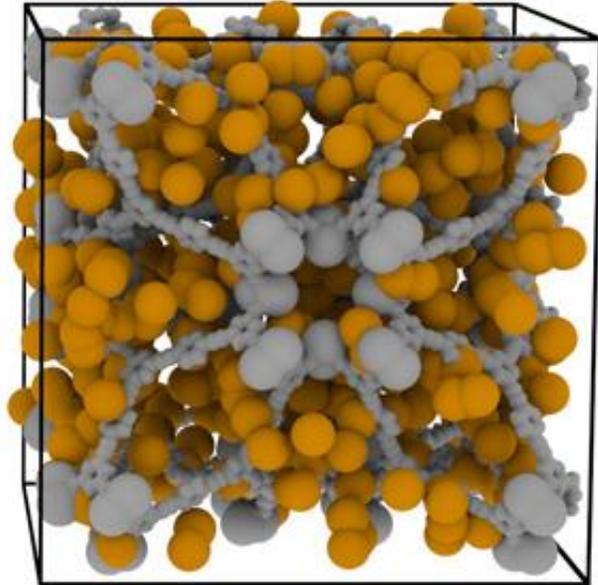
**Decline  
Collapse**



**In the News**

High Surface Area Crystal Sponges

# MOFs – Metal Organic Frameworks



Northwestern  
Image by Christopher Wilmer/NuMat Technologies)



Science Journal



In late 2018 Tokyo Gas will sell solid natural gas (MOFs) in 7-11 stores as fuel for portable micro fuel cells that recharge devices.



**True**

**False**

# Dubai Testing Retail based Fuel Distribution for EV Scooters

# STOR-H



**Could fuel-based  
micro-power systems  
be at same developmental stage  
as cell phones in early 1990s?**

 kraftwerk



\$49 (12 cartridges)  
11 phone charges per cartridge

# Disruptive Idea: External Recharger vs Embedded Fuel Cell Power



## Apple granted portable fuel cell power system patent

Apple has been granted a patent for an external portable fuel cell electricity generation unit designed to power portable computing devices.



By [Leon Spencer](#) | March 18, 2015 -- 05:55 GMT (22:55 PDT) | Topic: [Apple](#)

## Apple files patent for MacBook fuel cell that could last weeks

APPLE / 04 SEPTEMBER 15 / by JAMES TEMPERTON

## Disruptive Idea: Embedded Fuel cell Power

# One week battery life on an iPhone 6? It's possible

POSTED 1:49 PM, AUGUST 28, 2015, BY CNN WIRE



Intelligent  
Energy



*An Apple iPhone and a quadcopter, both retrofitted with hydrogen fuel cell batteries, and a hydrogen fuel cell are displayed by Intelligent Energy at ShowStoppers. Photo by Ann Singer.*



## Longer Battery Life = Energy consumer's 'faster horse' thinking?

MyFC predicts that fuel cells will surpass batteries in energy density and cost efficiency in a few years



YOUR POWER SOURCE

MyFC initiates feasibility study with leading Chinese smartphone manufacturer

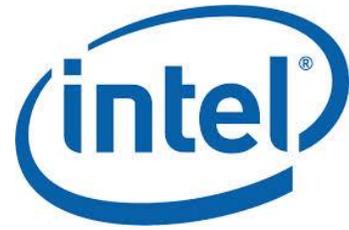
"Since we launched the world's smallest fuel cell LAMINA in early 2017, our intention has been to pursue the integration of our fuel cell technology in smartphones. This R&D project marks the start of that initiative, which we refer to as job #3," says Björn Westerholm, CEO of myFC.

# What could happen in 12 years...?



Hardware Makers  
Unite to Kill Battery

2022



Opens Fuel-cell  
Plant in China

2024



Unplugging at  
Burning Man



2027



House Construction  
without Electrical Sockets



Vision: #1  
Fuel Distributors

2030



# What if fuel-based innovations capture the head, heart & wallets of the our communities?

## Retail-shelf energy becomes unexpected innovation of 2020s:

- Customers *cut the cord* and reduce grid-use
- New types of competition + coopetition emerge
  
- Do we get into the portable fuels business?
- Do we get into managed services of embedded systems?
- Do we support a range of fuel mixtures: traditional CH gases, hydrogen (renewable vs natgas derived) and synthetic gas?



**End**



**Transitions Ahead**

***Next Steps***

# Anticipating Transitions & Shifting Expectations



- 1) Consumerization  
& Data-driven Innovation***
- 2) Distributed Energy Resources**
- 3) Electrification of Vehicles**
- 4) Blockchain Energy Applications**

## Shifting Expectations for Utilities & Solution Providers

Legacy Phase...

**Build out Access  
to Infrastructure**



Consumerization Phase...

**Managed Services,  
Transactions &  
Behavior Change Solutions**

# Social Norms for the Anonymous-Access Web

1993



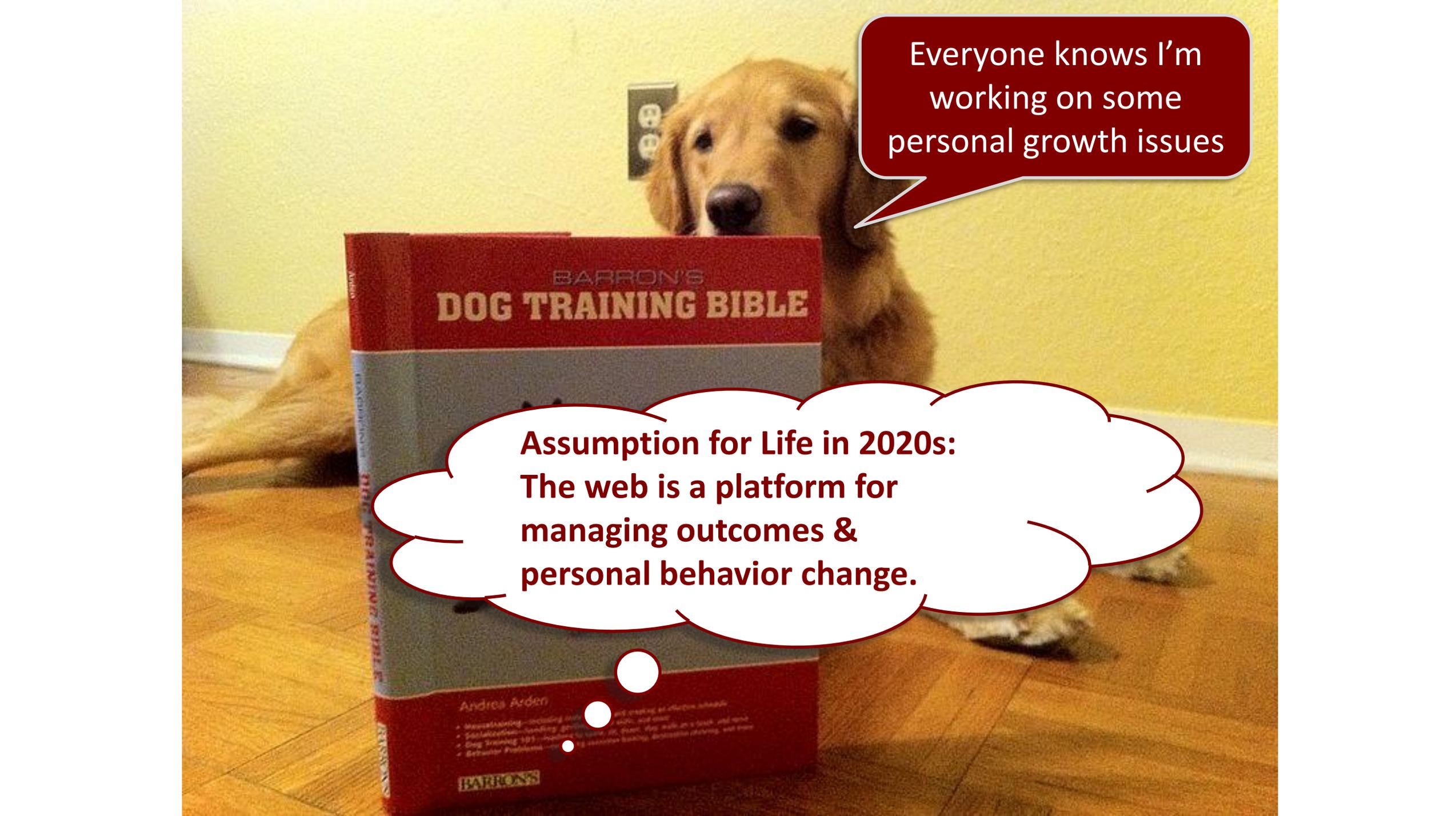
*“On the Internet, nobody knows you’re a dog.”*

“On Facebook, 273 people know I’m a dog.  
The rest can only see my limited profile.”

# Social Norms & the Social Web

2008





Everyone knows I'm  
working on some  
personal growth issues

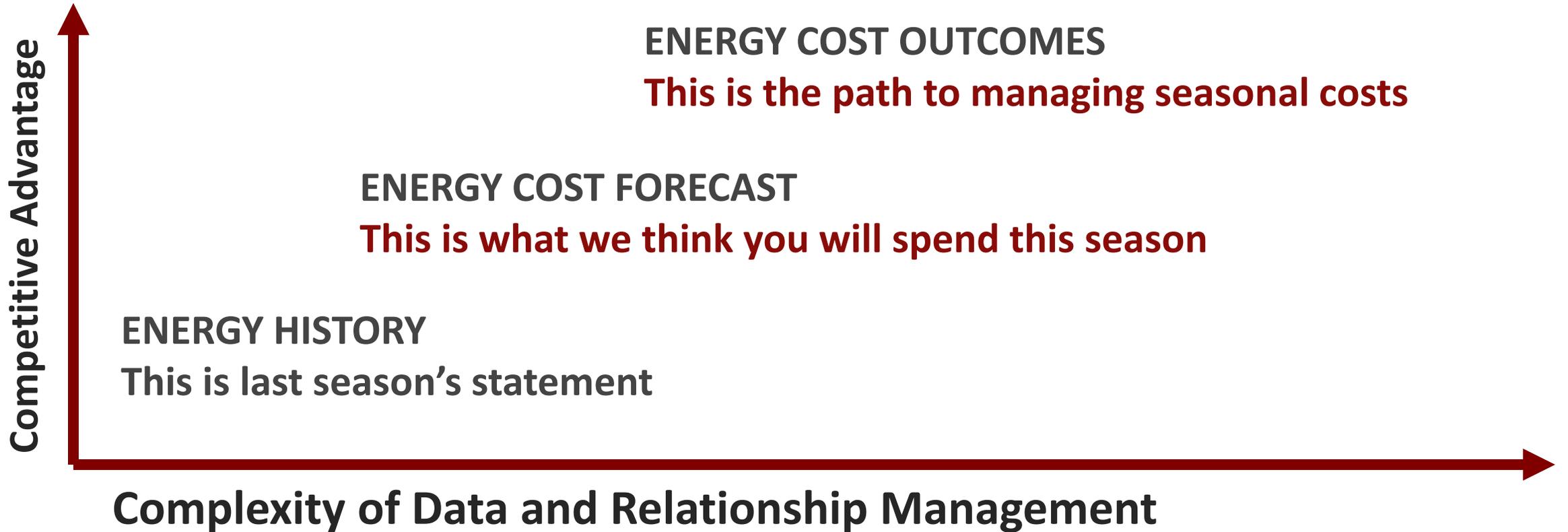
**Assumption for Life in 2020s:  
The web is a platform for  
managing outcomes &  
personal behavior change.**

Consumerization & Service + Experience Design

## Data + Behavior Change to Guide Outcomes?



# Guided Energy Experiences



Assumption: Lower Barriers to Entry Remain

# Energy Experiences Reshaped with Connected Devices

neurio



**Focus on Integration**  
**Plug + Play Energy**  
**Management Solutions**

ecovent  
EMERSON  
Climate Technologies



2018 – 2025

# Tipping Point for Home-Life Management Systems?

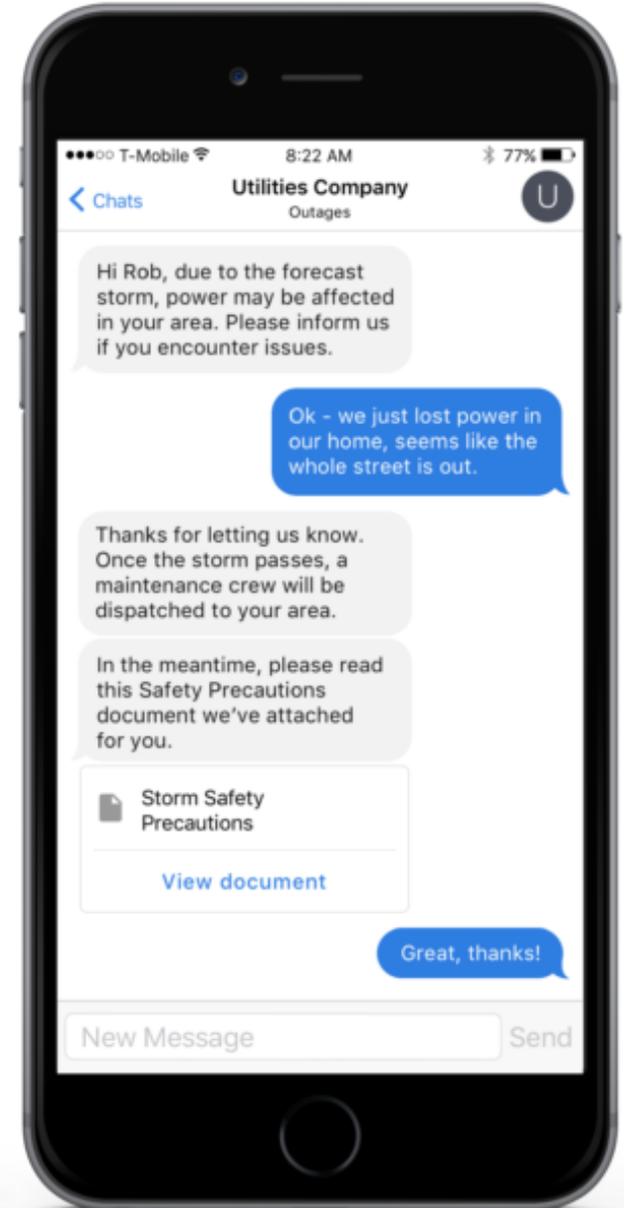
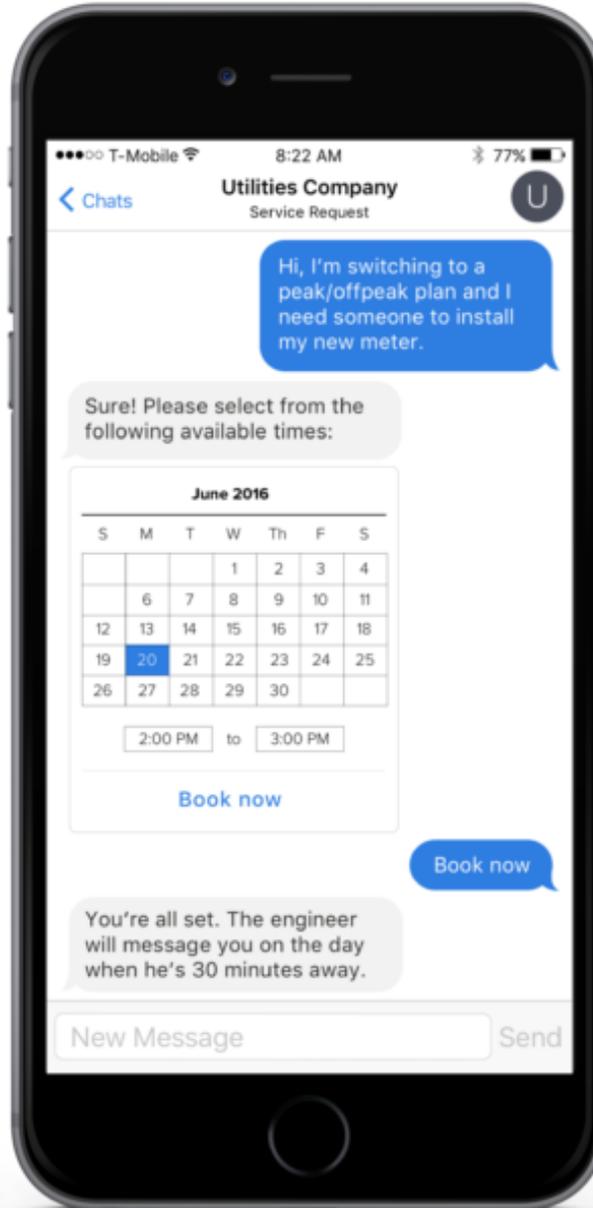
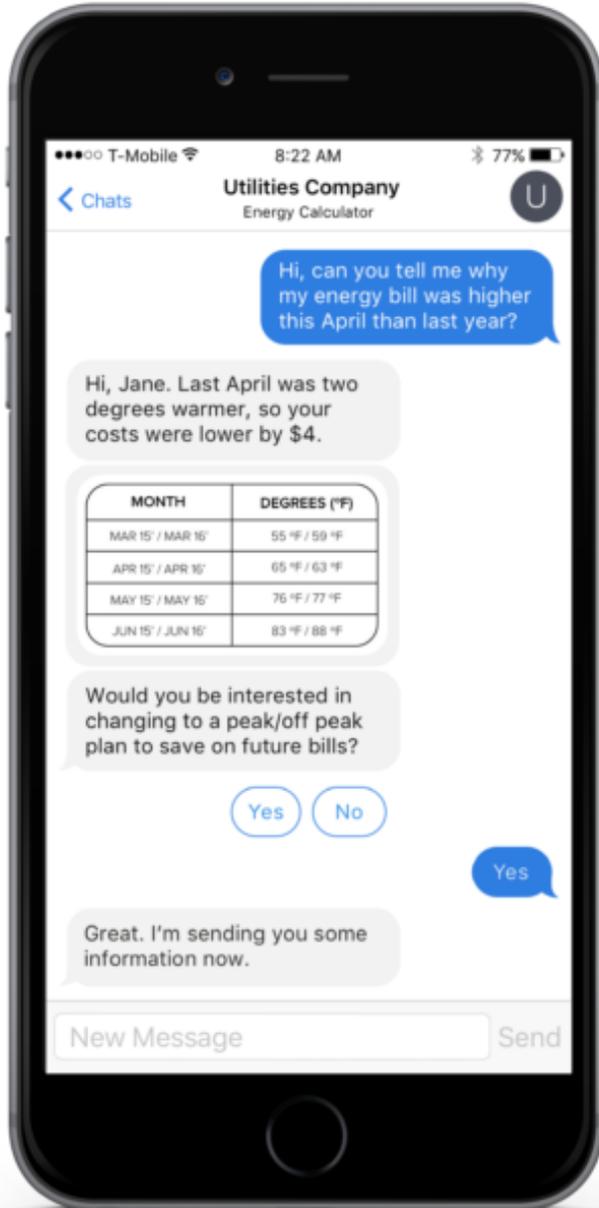
**Anticipate Need for Strategic Partnerships**  
Prepared if major players dominate connected home experience and service extensions

## Ecobee3 Thermostat Can Be Controlled By Amazon Echo

By Tyler Lee on 02/12/2016 15:12 PST



# Rolling Eyes at *Silly Chatbots* vs Taking Messaging Seriously



**Consumerization**  
**Data-Driven Innovation**

## **Opportunities**

- Align with Changes**
- Transform Service Model**

## **Challenges**

- Business Model**
- Privacy and “Creepy Line”**

# Anticipating Transitions & Shifting Expectations



1) *Consumerization*

*& Data-driven Innovation*

**2) Distributed Energy Resources**

3) *Electrification of Vehicles*

4) *Blockchain Energy Applications*



2018 – 2030

## Shifting Expectations for Distributed Energy Resources



# Embracing Policy Reform + Consumer-driven Dynamics of Solar



# Community Storage: Aggregated System level Solutions

"Community Storage" is an emerging term for programs that aggregate distributed energy storage resources that are located throughout a community, such as water heaters, electric vehicles, and interconnected storage batteries, to improve the operational efficiency of electric energy services to consumers.

## The Community Storage Initiative

[Join Our Email List](#)

### The co-founders of the community storage initiative ask for your support:

- Click on the link above to join the Initiative's email list to receive information about the Initiative and upcoming events
- Promote an "above the baseline" approach to electric water heating, electric vehicle charging, and residential battery use marketed as "Community Storage"
- Share your business model and best practices around "Community Storage"

### We ask you to follow the Guiding Principles of The Community Storage Initiative:

1. Voluntary Participation (by the utility, home, business or individual)
2. Education & Training (information resources, program templates, quick-start guides, etc.)
3. Market Acceptance (locally, regionally and nationally)

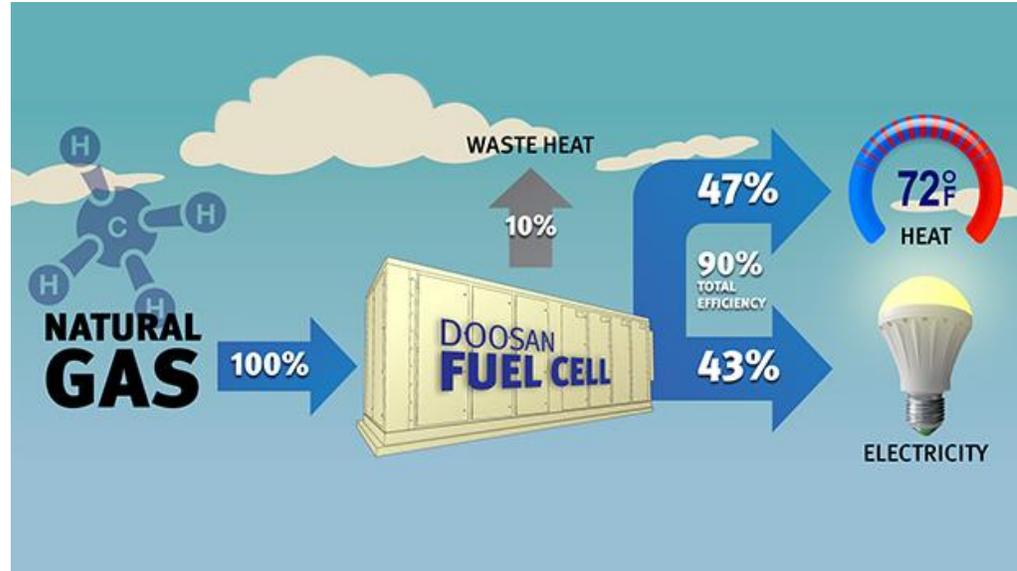


Strengthening Signals but Lingering Scars

## NatGas Friendly Vision: Fuel Cells as base of Micro Grids & CHP



Bloomenergy



DOOSAN

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**fuelcellenergy**

Connecticut Municipal  
**cmeec**  
Electric Energy Cooperative

Strengthening Signals but Lingering Scars

## Connecticut is California of East Coast

**GOVERNMENT  
PRODUCT NEWS**

Fuel cells: Local and state governments turn to them for resilient power generation



15MW Dominion  
Bridgeport Fuel Cell Park

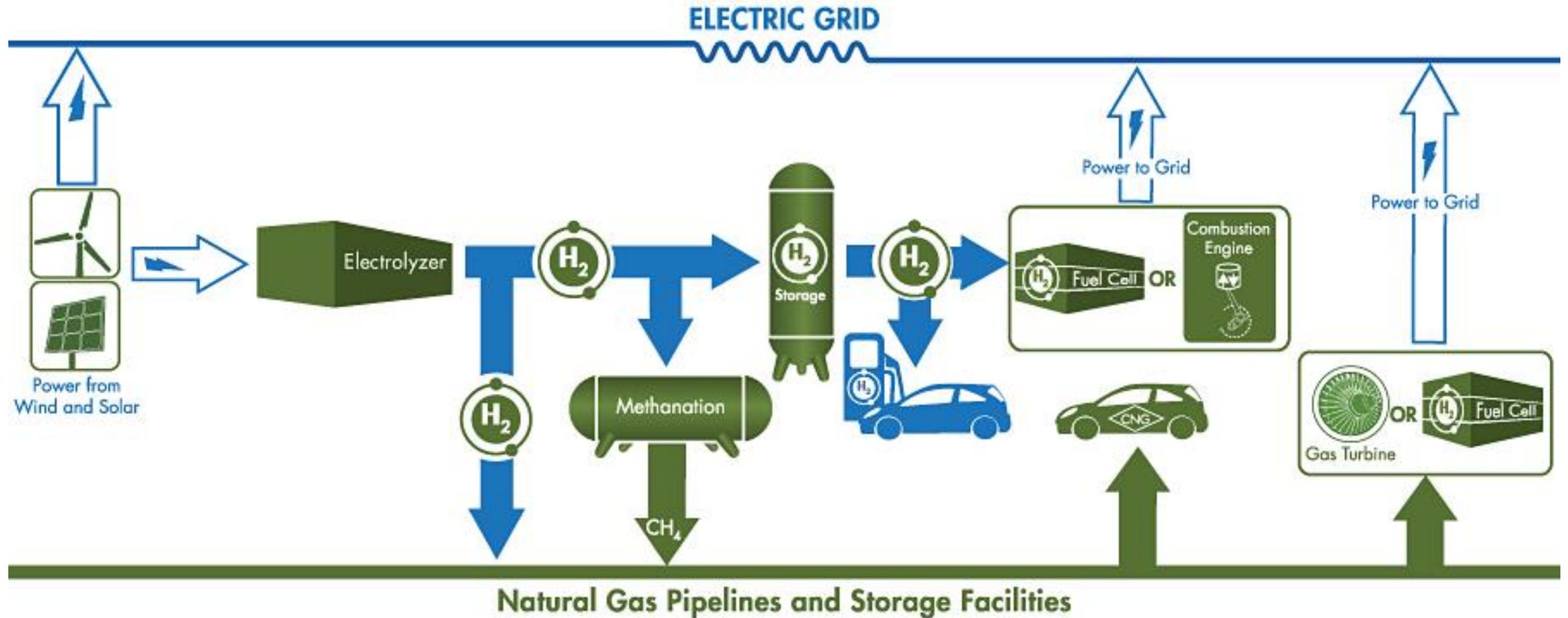


63MW Beacon Falls (Approved)



Incumbents are Starting to Show Interest

## Energy Storage at Scale: Power to Gas



Power-to-Gas Energy Storage is the lowest cost long duration energy storage technique known. 10 hour systems cost £80/kWhr; that's a fraction of the cost of any battery storage system.

## **Distributed Energy Resources**

### **Opportunities**

- Resiliency & Community Spirit
- Expand Service Area
- Reduce Long-term Expenditures
- Empower Commercial Clients

### **Challenges**

- Balancing Motivation + ROI
- Understanding Grid + Gas Dynamics

Tapping Inner Futurist:

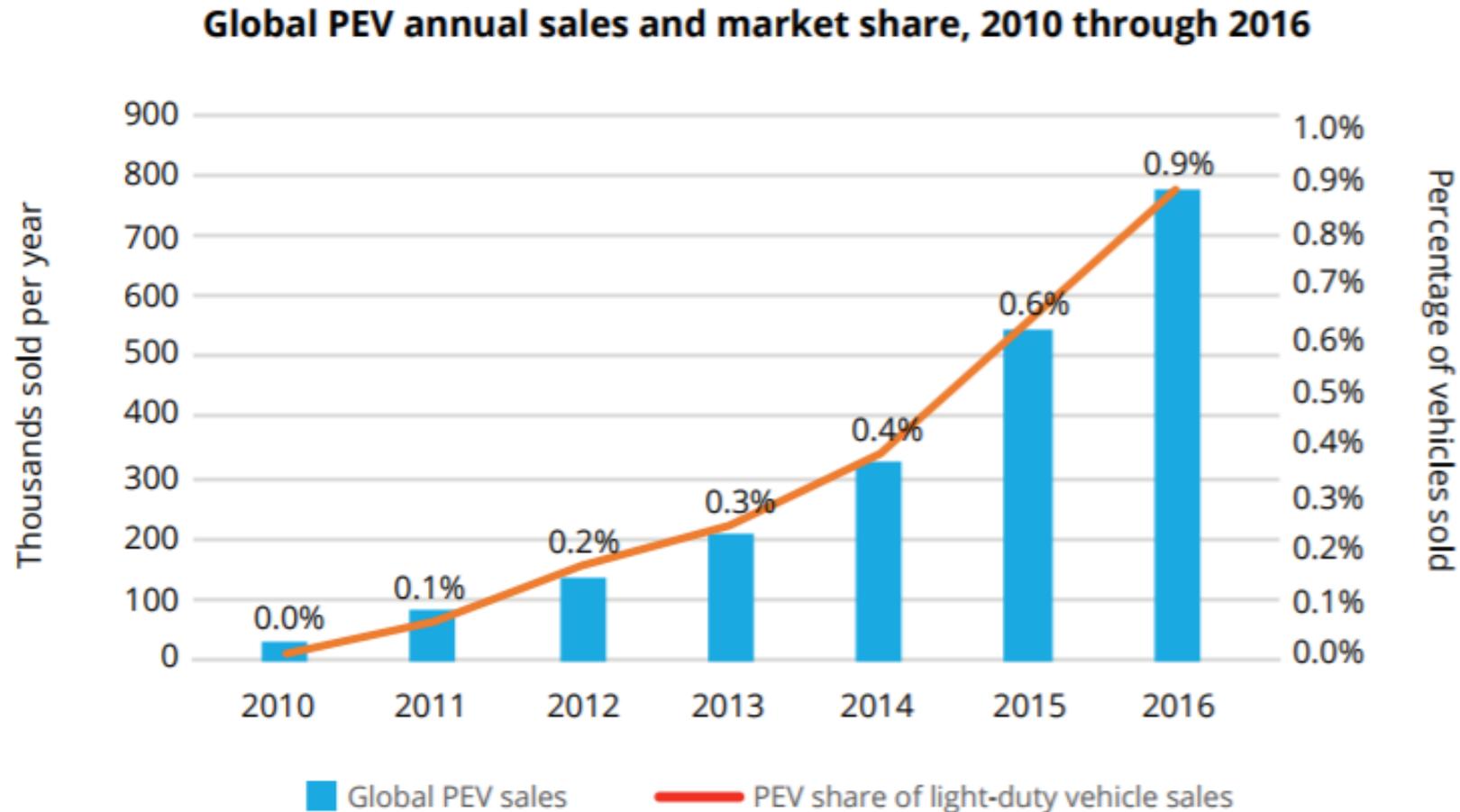
## *The Slow Pace of Fast Change: 2018 – 2030*



**Transitions Ahead**

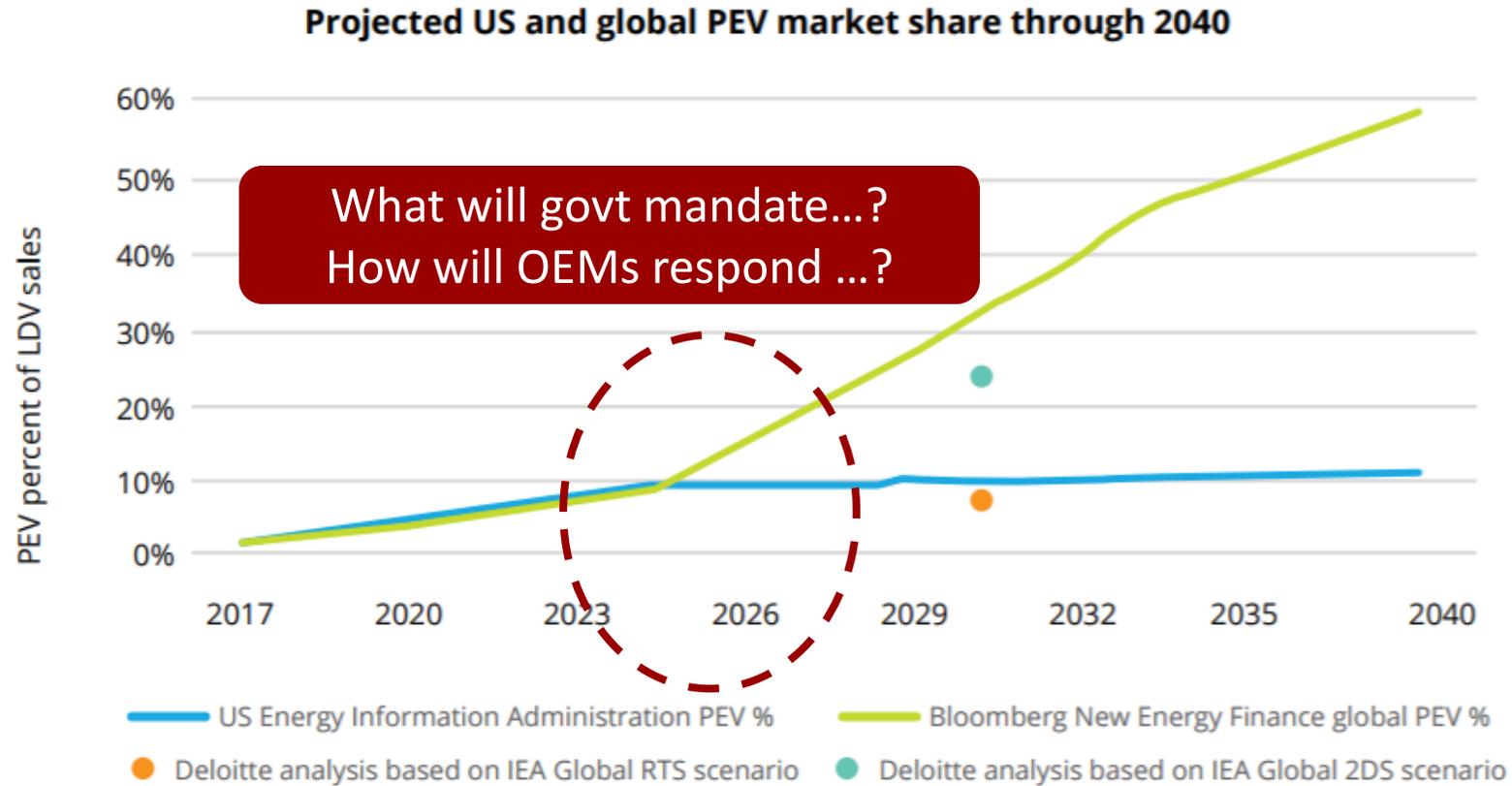
- 1) *Consumerization  
& Data-driven Innovation*
- 2) Distributed Systems
- 3) Electrification of Vehicles**
- 4) Blockchain Energy Applications

# Electrification of Vehicle Fleet



Source: Electric Drive Transportation Association, "Electric drive sales dashboard," and Jeff Cobb, "Top ten plug-in vehicle adopting countries of 2016," HybridCars, January 17, 2017.

Figure 2. Projected PEV share of total light-duty vehicle sales



The IEA's Reference Technology Scenario (RTS), projecting 56 million electric cars in circulation by 2030, reflects projections that respond to policies on energy efficiency, energy diversification, air quality, and de-carbonization that have been announced or are under consideration. The IEA's 2DS scenario, projecting 160 million EVs in circulation by 2030, occurs in a context consistent with a 50% probability to limit the expected global average temperature increase to 2°C. We estimated annual sales required to meet IEA's EV stock projections for 2030 and then calculated the EV share of sales as a percent of total light-duty vehicle sales projected by Bloomberg New Energy Finance for 2030.

Source: Deloitte analysis.

# Electrification of Vehicle Fleet: The Long Game & Big Picture



*Hybrid ICEs*



*Plug-in EVs*



*Fuel-based EVs*  
*Hydrogen Rich Fuels*

# Marathon, Not a Sprint



***... Elon Says  
Game-Over  
Batteries Won!***

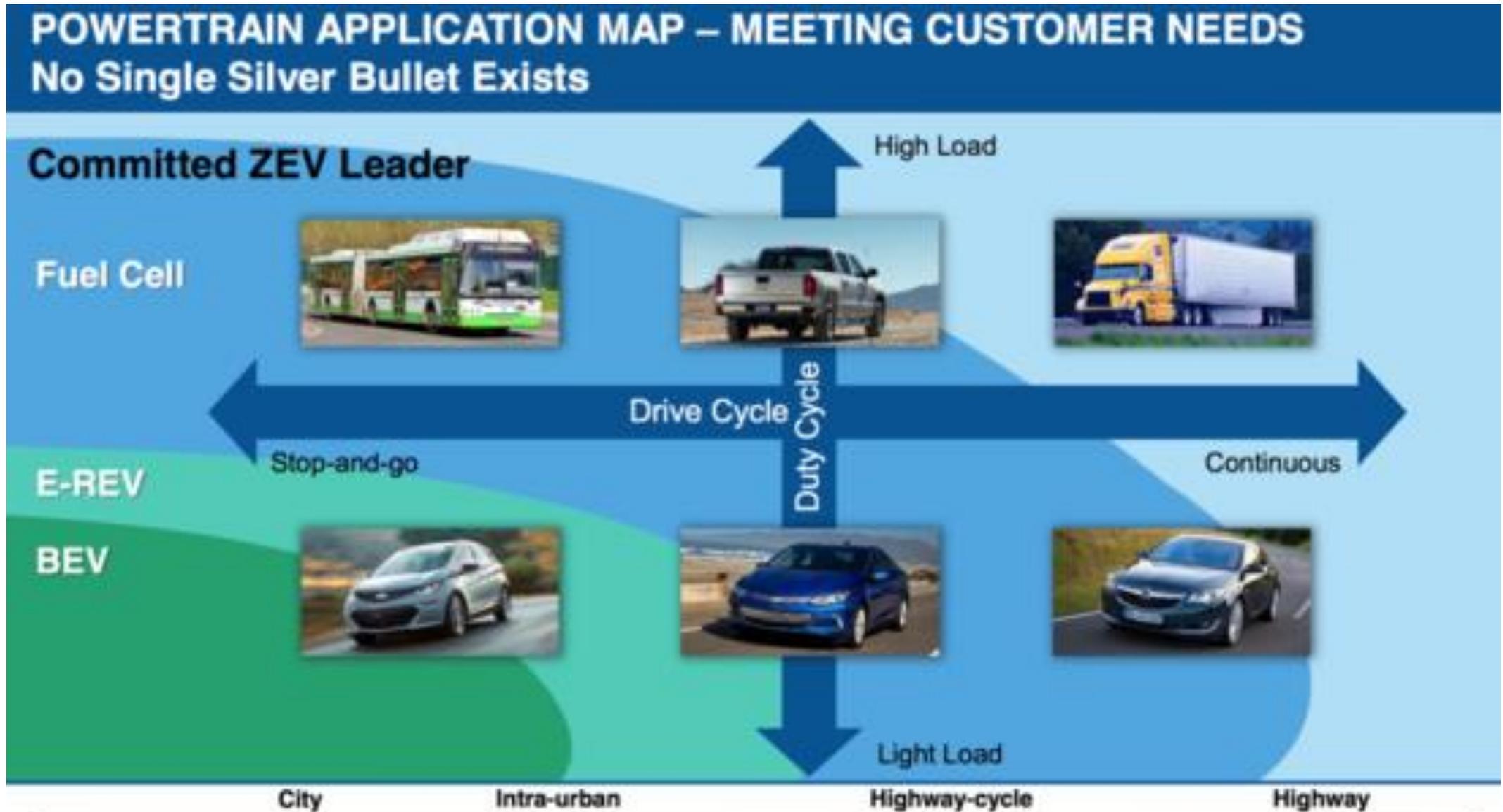


More than three-quarters of executives (77% global; 85% U.S.) say fuel-cell electric mobility will be the real break-through for electric mobility.



***... but Industry betting on  
integration & fuel-based EVs***

# Caution on Early Bets with Electric Vehicle Transition



## **Electrification of Vehicle Fleets**

### **Opportunities**

- Vehicle to Grid (V2G) Service Model
- Managed Services for Fleets
- Transform Excess Electrons  
to Higher Value H2 Fuel

### **Challenges**

- Viability & Sustainability
- Regulatory Certainty
- Business Model

## Tapping Inner Futurist:

### *The Slow Pace of Fast Change: 2018 – 2030*



**Transitions Ahead**

- 1) *Consumerization  
& Data-driven Innovation*
- 2) Distributed Systems
- 3) Electrification of Vehicles
- 4) **Blockchain Energy Applications**



## World Economic Forum Survey Projects Blockchain 'Tipping Point' by 2023

**“By 2025, 10% of Global GDP will be orchestrated by blockchain applications.”**

## Implications of the blockchain cannot be understood... yet



1994: "Today Show": "What is the Internet, Anyway?"

# Evolution of the Web-based Capabilities & Solutions



***Access to  
Digital Files***



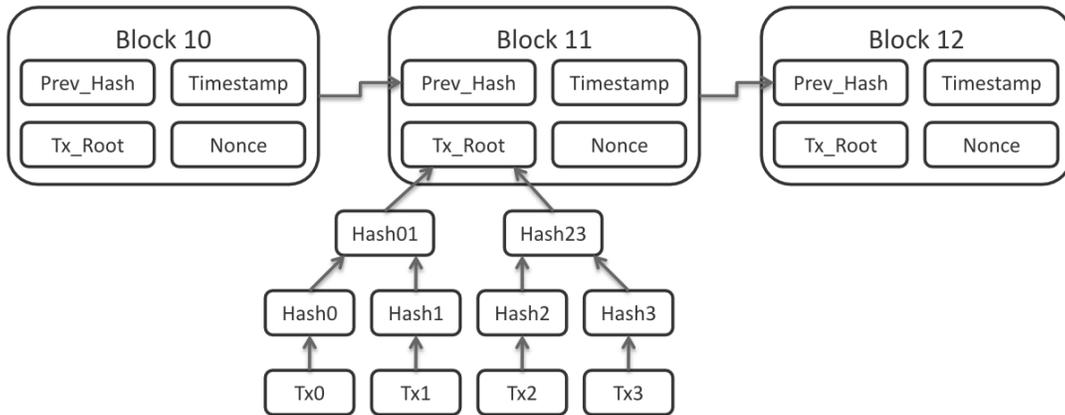
***Access to  
Social Networks***



***Access to  
Trusted Transactions***

# It's just Decentralized Databases + Process Automation!

**Assets get entered onto the ledger and generate keys** + **Network Consensus on who did what...**



**'Assets' for Utilities, Businesses and Residents=**  
**Energy Usage Data, Bills, Appoints, Crew Field Notes**  
**Identity, Credit Card Information, Equipment Repairs...**

**Smart Contracts execute legal agreements + business processes**

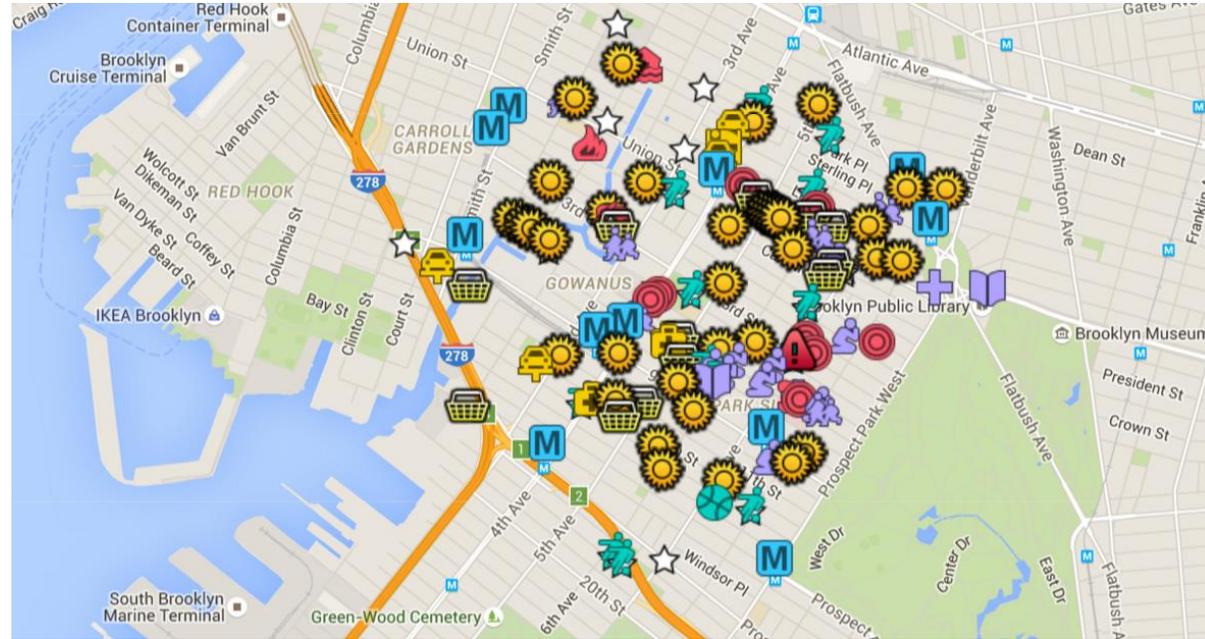
A sample of EtherScript

```
note: ""An Ethereum smart contract to sell website for "5000 by March"  
note: First, store buyer's ethereum address:  
put: 6af267736363738ghgs7726337373737 in storage slot BUYER  
note: Then, store seller's ethereum address:  
put: 6af267736363738ghgs7726337373737 in storage slot SELLER  
note: April 1, 2014 is 13929839948 in "computer time"  
put: 16365437465 in storage slot DEADLINE  
note: If the agreed amount is received on time...  
When: transaction value >= 5000 ether  
and block timestamp <= storage slot DEADLINE  
then  
note: ... then designate the buyer as the new website admin and pay the seller  
put storage slot BUYER in storage slot WEBSITE_ADMIN  
Spend contract balance to storage slot SELLER
```



**Authorization for Data use;**  
**Revenue Cycle Management;**  
**Front-end Compliance Walls;**  
**IoT Cyber Security;**  
**Wholesale Trading**

# Blockchain as Backbone for Microgrid?



**Neighbor-to-Neighbor Energy Sales**  
**Crowd-funding Community Energy Assets**  
**Economics for Behavior Change (Negawatts)**

# Hype Phase for Blockchain Energy Platforms



Meet your new agent

The Grid+ Smart-Energy Agent is an always-on device that pays for your electricity in real time and always finds the best price available.

## RESPOND TO DEMAND

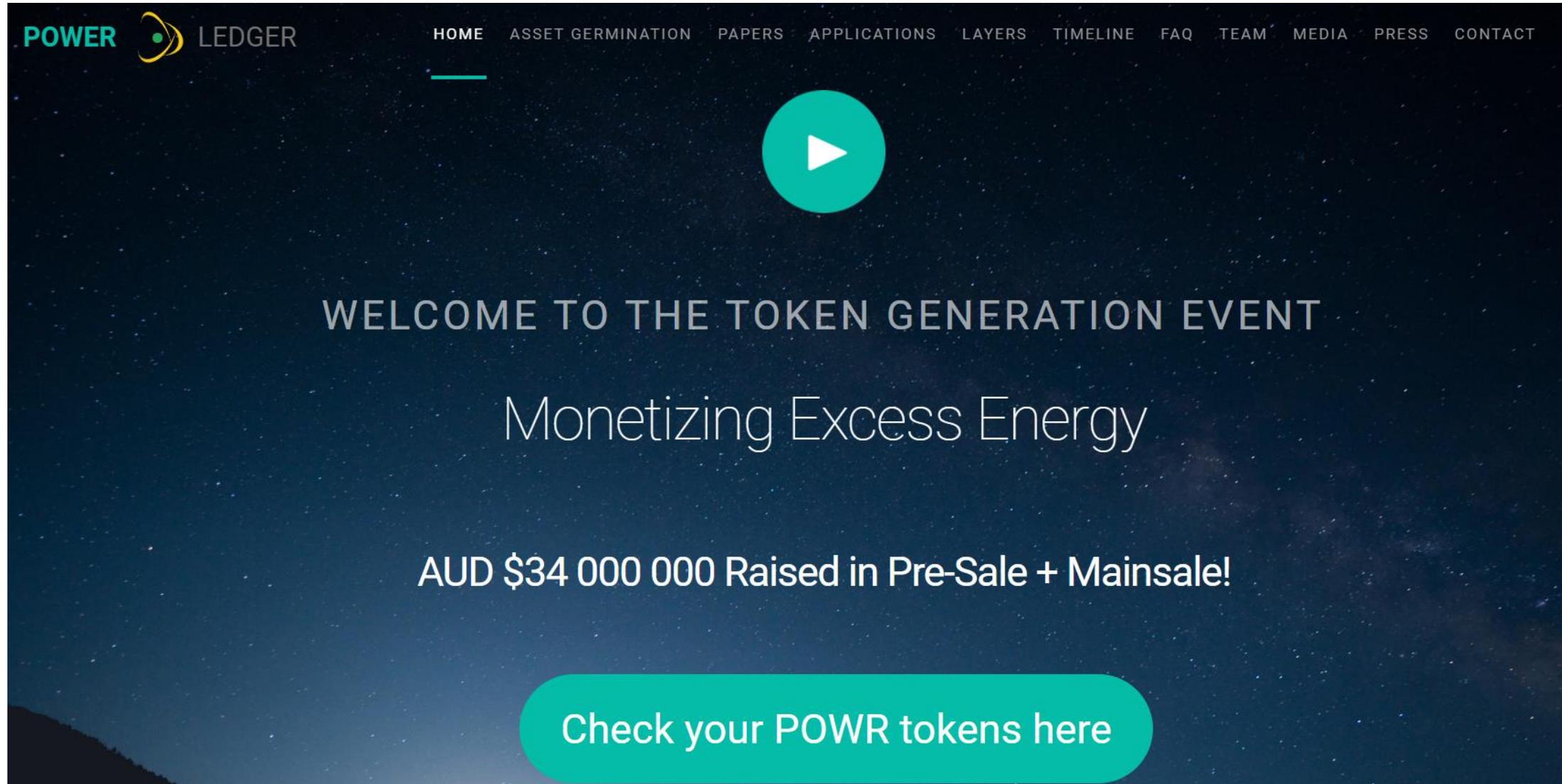
The intelligent agent can help balance load on the grid by controlling smart devices, such as a NEST thermostat or a Tesla Powerwall, to generate extra revenue.

## ARBITRAGE ENERGY

Your agent can leverage energy storage, such as the Tesla Powerwall, to purchase energy when it is cheap and sell it when prices peak.



# Hype Phase for Blockchain Energy Platforms



**POWER**  **LEDGER**

[HOME](#) [ASSET GERMINATION](#) [PAPERS](#) [APPLICATIONS](#) [LAYERS](#) [TIMELINE](#) [FAQ](#) [TEAM](#) [MEDIA](#) [PRESS](#) [CONTACT](#)



WELCOME TO THE TOKEN GENERATION EVENT

Monetizing Excess Energy

AUD \$34 000 000 Raised in Pre-Sale + Mainsale!

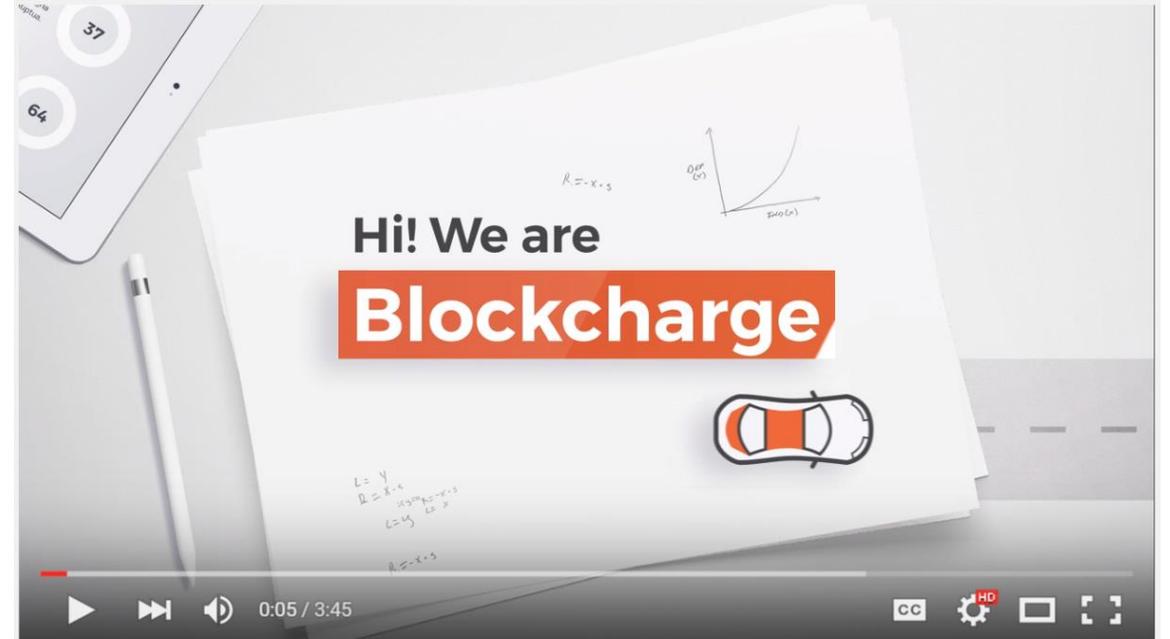
[Check your POWR tokens here](#)

# Innovative Proof of Concepts... Shared Infrastructure

## Innogy Charges New Electric Car Fleet Using Ethereum Blockchain

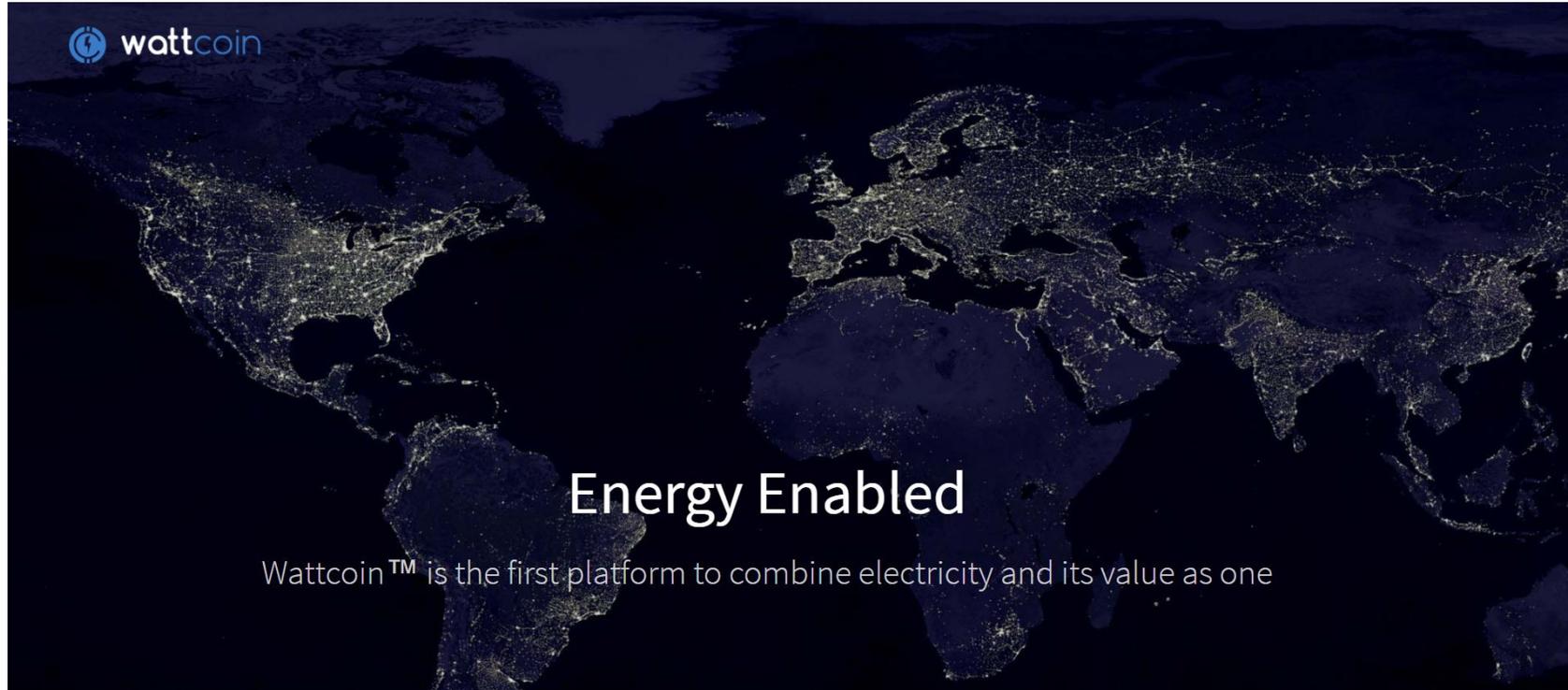


[Innogy SE](#), a subsidiary of German energy conglomerate RWE, announced that it has launched hundreds of blockchain-powered charging stations for electric cars across Germany through its e-mobility startup venture [Share&Charge](#).



[BlockCharge - EV Charging via the Ethereum Blockchain \(HQ\)](#)

# Innovative Proof of Concepts... Payment + Access



### PayGo & Microgrid Service Providers

Use Wattcoin to get paid for delivering solar electricity anywhere that kerosene and diesel is used



### Utility & Smart Grid Systems

Use Wattcoin with smart grids to create real-time demand response rewards for energy efficiency

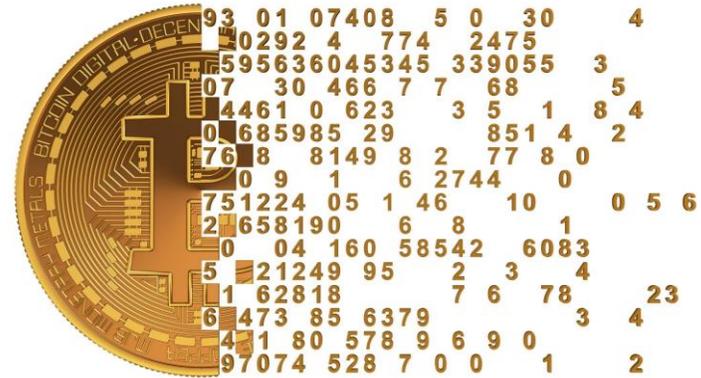


### Market & Peer-to-Peer Exchanges

Use Wattcoin on blockchain enabled exchanges between prosumers and consumers of clean energy

# Radical Idea: Crypto Currencies Tied to Behavior Change

**Crypto Currencies +  
Smart Contracts automate  
incentives for energy  
demand management**



**Utilities Issue Negawatts**

Images Removed

# Create a Healthy Sense of Urgency

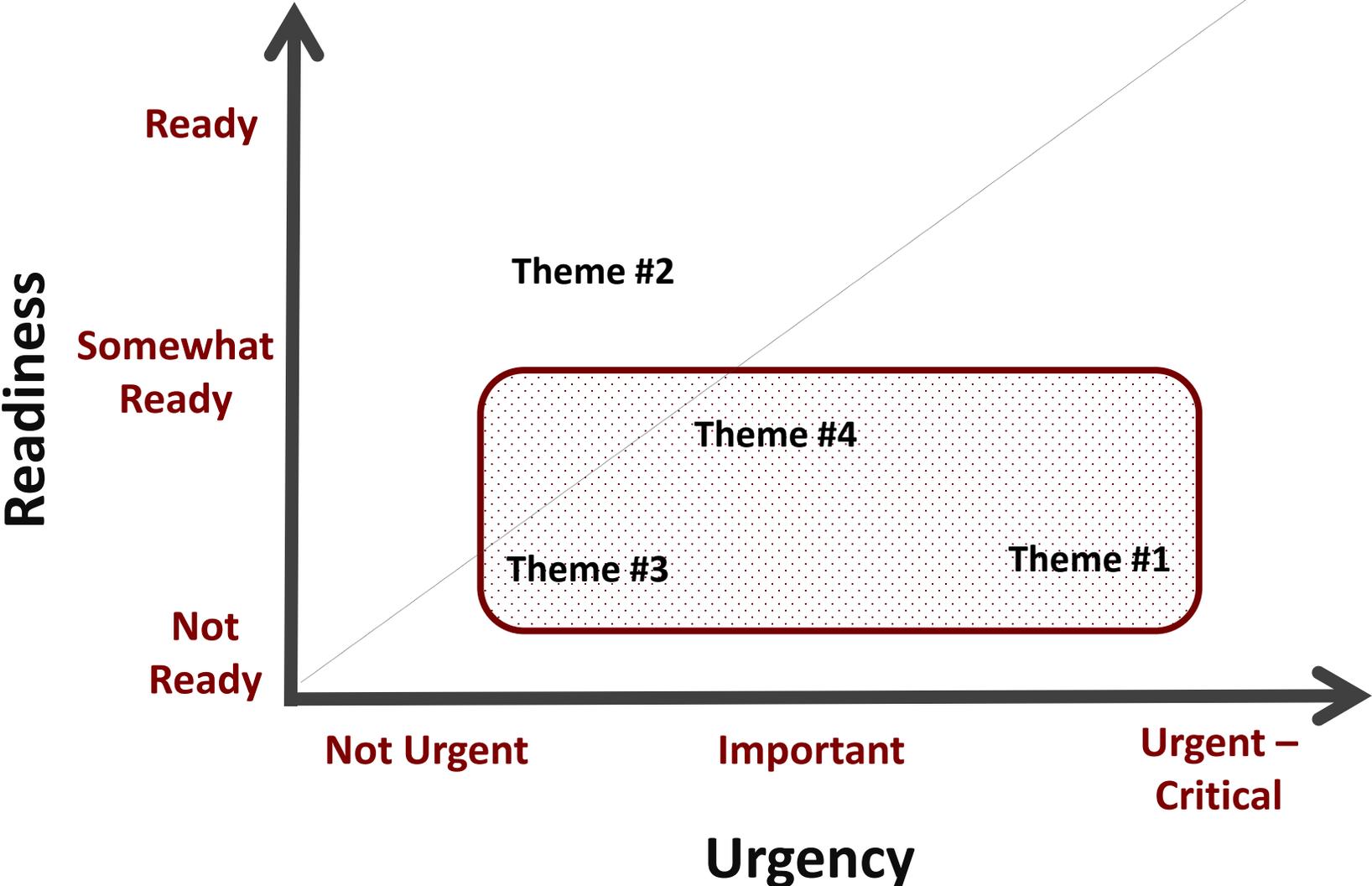
## *On the Plateau 'Managing the Decline'*

- Incumbent mindset
- Incremental Improvement
- Fear, Uncertainty,  
Doubt & Denial

## *Walking up Hill Enabling New Era*

- Entrepreneurial mindset
- *Prototyping*  
*Transformative Change*
- *Failing Forward*

# Take a Pulse Check on Emerging Trends vs Organizational Appetite



# Establish Thought Leadership + Curator Role on Big Ideas

**Engage staff, elected officials and community leaders in socializing 'big ideas' on the horizon of the energy sector.**

- Energy Entrepreneurship
- Distributed Generation
- Business Model Challenges
- EVs (Battery + Fuel cells)
- Connected Devices + IoT  
(Data-Privacy-Security)
- Blockchain + Crypto DApps

Give Structure to Innovative Thinking!

## **Use 'Killer Questions' to Brainstorm Ideas**

What is a need that does not exist today but in five years will be our most requested product/service from our communities?

What skills set will be most in demand in five years that we do not currently address in formal training programs?

What job title does not exist today but in five years will be on our most valued positions within the POU?

# Thank You!!

PDF + Resources

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Two Rs

