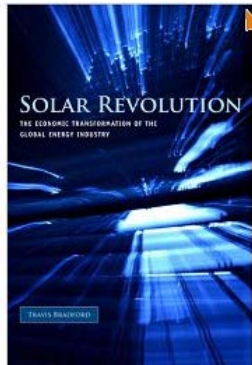# The End of the Distributed Revolution

Travis Bradford,
Executive Chairman, WATT Fuel Cell
President, Prometheus Institute
Professor of Professional Practice, Columbia University

SOLAR REVOLUTION
THE ECONOMIC TRANSFORMATION OF THE GLOBAL ENERGY INDUSTRY
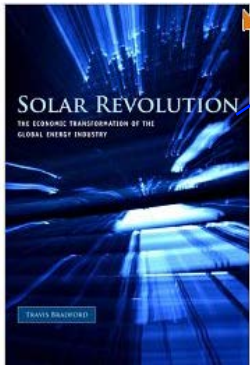
TRAVIS BRADFORD

The three goals of electricity provision
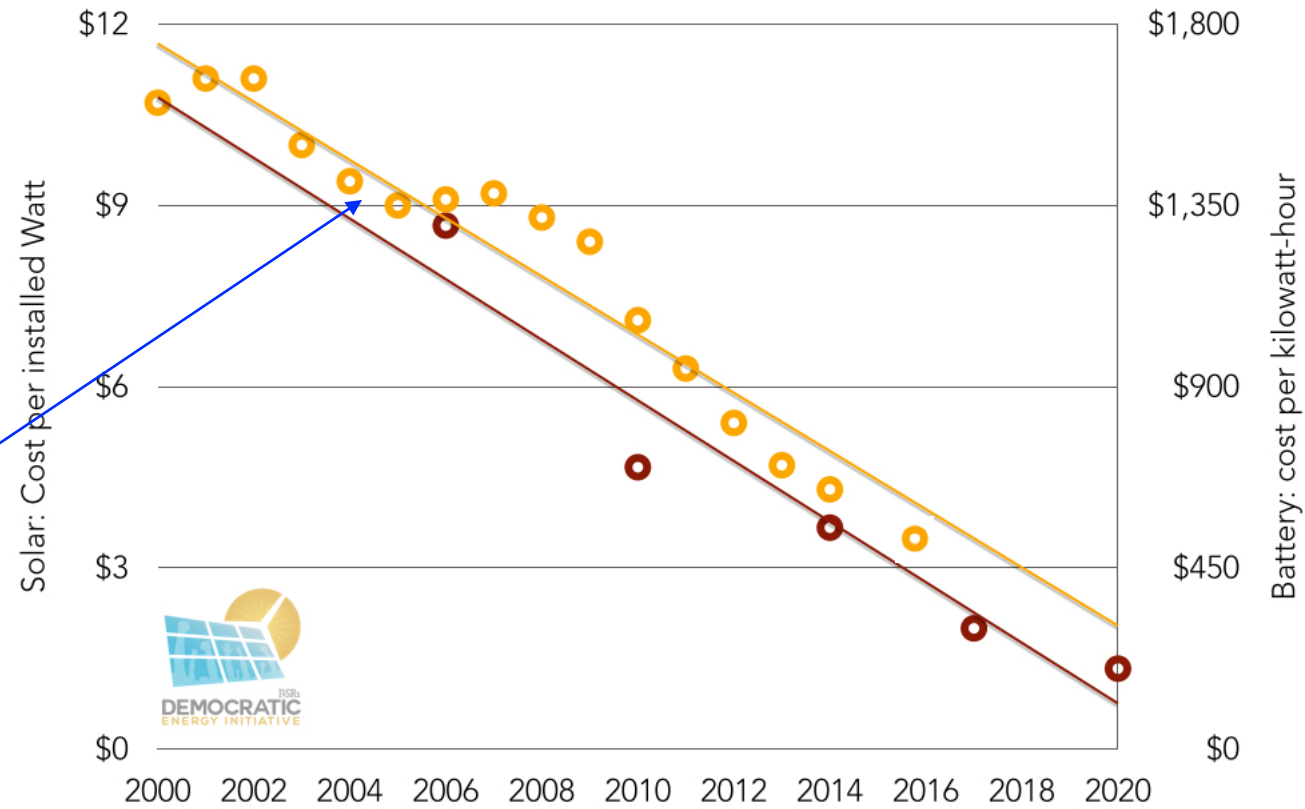
1. Low Cost

2. High Reliability

3. Lower social and environmental impacts
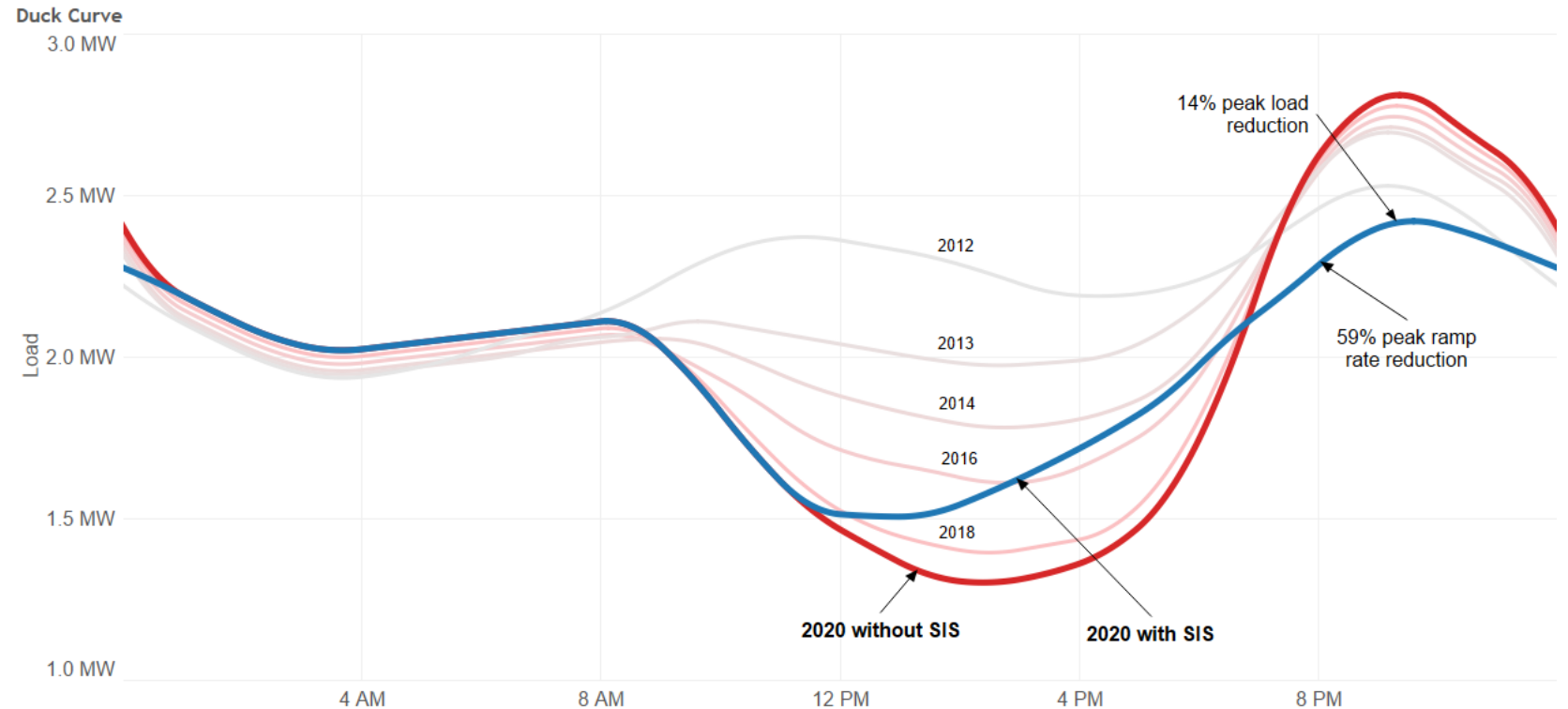
A disruptive challenge, indeed…
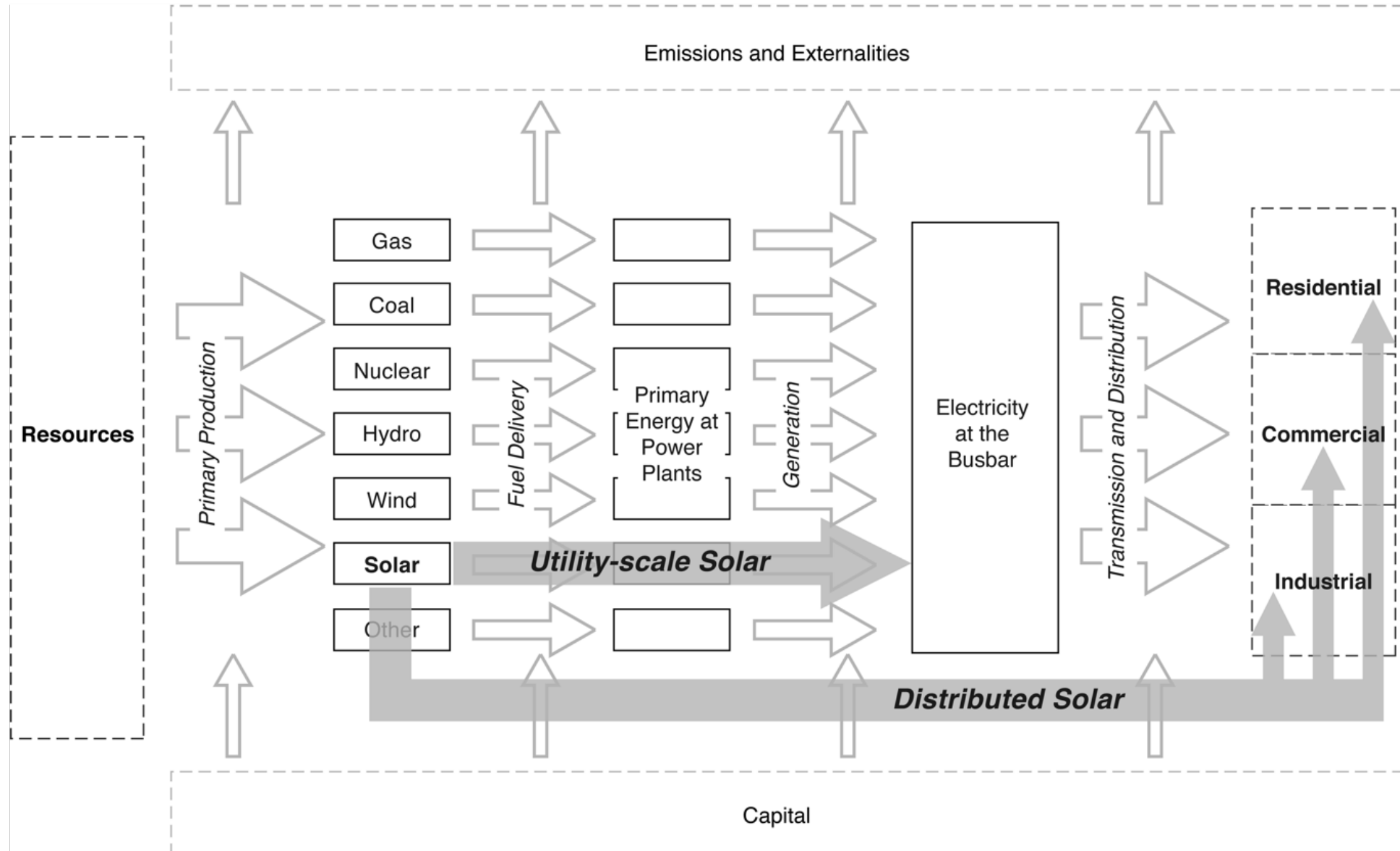
Experience Curves steep for solid state tech

ROOFTOP SOLAR AND BATTERY STORAGE PRICES KEEP FALLING

The Duck Curve – Not ideal for system needs


Duck Curve

Load (MW): 3.0 MW, 2.5 MW, 2.0 MW, 1.5 MW, 1.0 MW

Time: 4 AM, 8 AM, 12 PM, 4 PM, 8 PM

Years labeled: 2012, 2013, 2014, 2016, 2018

14% peak load reduction

59% peak ramp rate reduction

2020 without SIS

2020 with SIS

The Death Spiral – Grid Defection

FIGURE 6: PRESSURE ON TRADITIONAL UTILITY BUSINESS MODELS

ENTREPRENEURIAL ATTACK
- Declining technology costs (e.g., solar, storage)
- Alternative business models from new attackers
- Customers seeking alternative "non-commoditized solutions" (e.g., resiliency, "green-ness")

TRADITIONAL UTILITY MODEL UNDER SIEGE
- Must deliver against 3-part commitment for reliable, cost-effective, and environmentally-responsible power
- Must meet stakeholder fiduciary responsibilities

UPWARD PRICE PRESSURES
- Aging grid repair and resiliency upgrades
- Smart grid investment
- Environmental controls and forced fossil retirements
- Energy efficiency success

REALLOCATION EFFECTS SPUR OUTSIDE COMPETITION
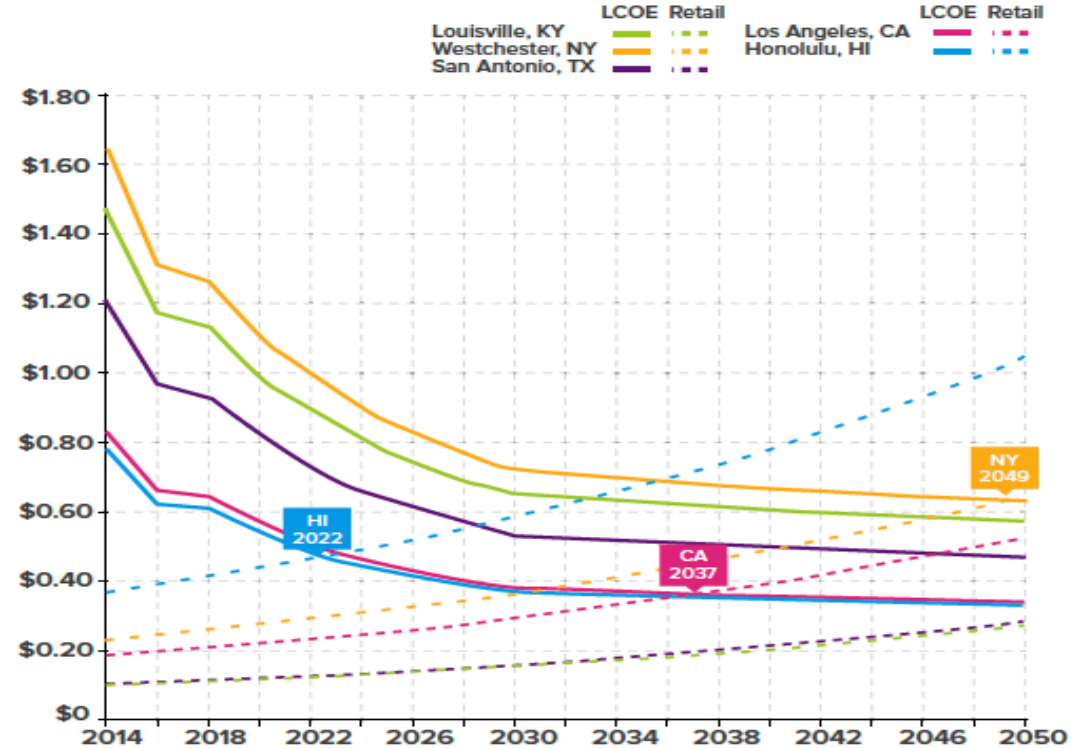
DEFECTION SPREADS FIXED COST OVER FEWER PEOPLE

6

Grid Defection threatens permanent disruption?

FIGURE 1: OFF-GRID VS. UTILITY PRICE PROJECTIONS
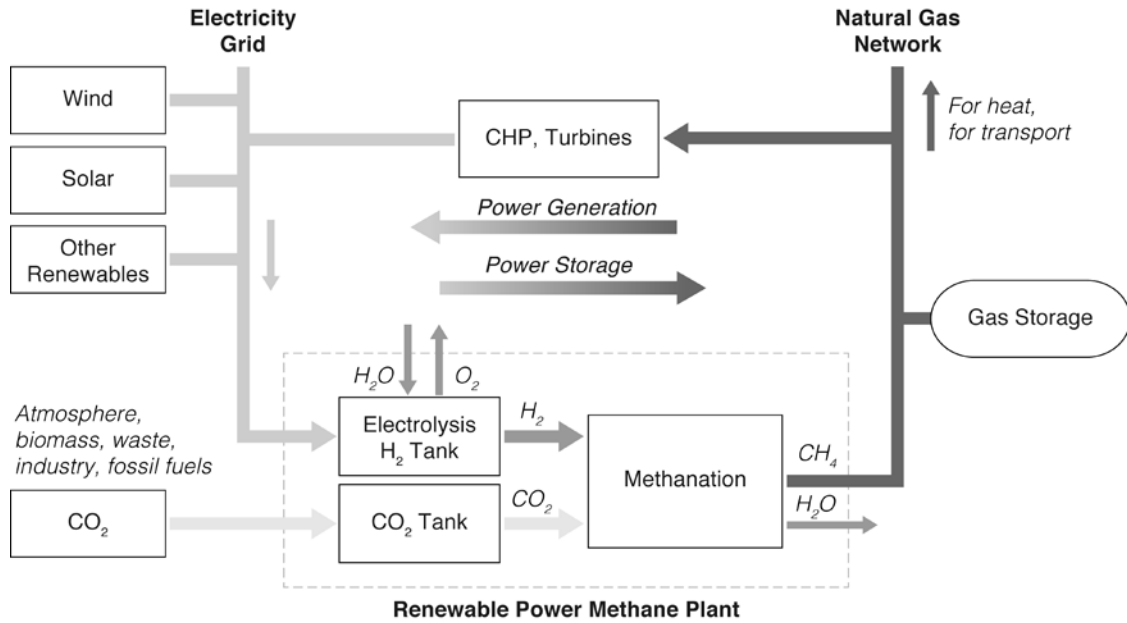COMMERCIAL - BASE CASE
[Y-AXIS 2012$/kWh]
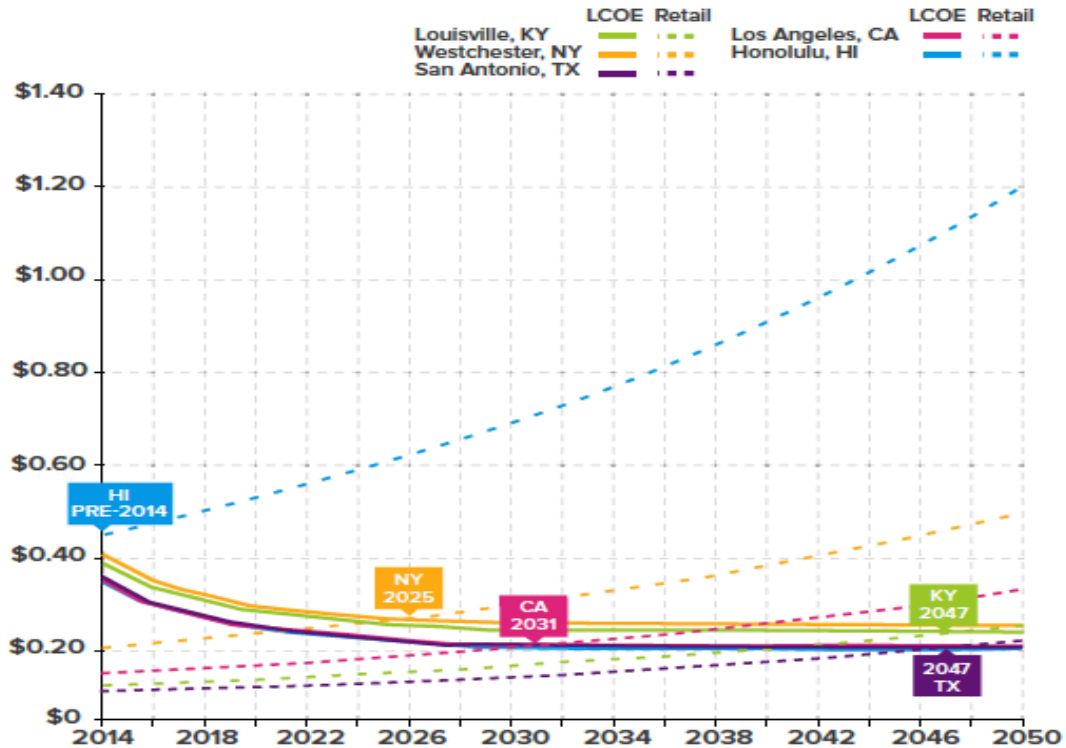
FIGURE 2: OFF-GRID VS. UTILITY PRICE PROJECTIONS
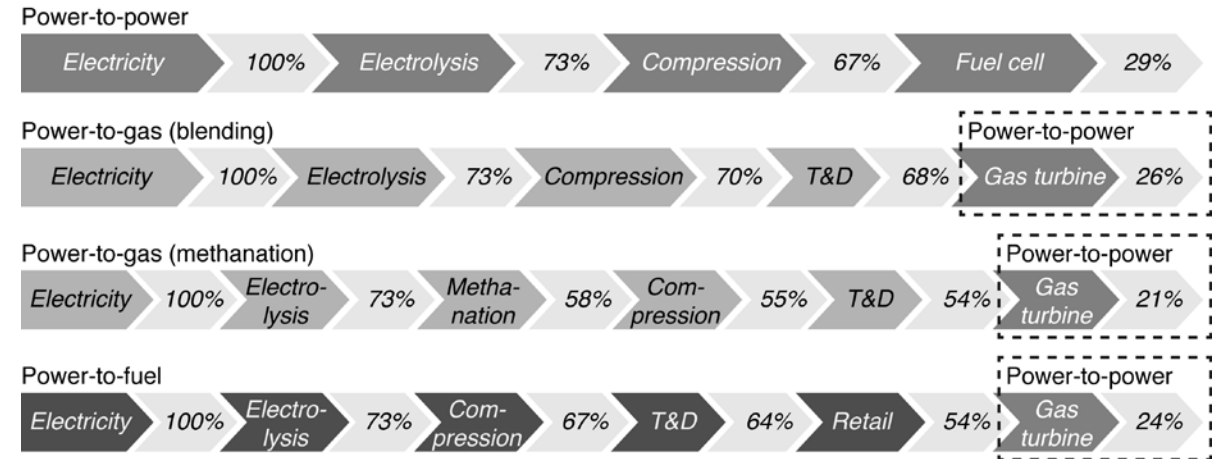RESIDENTIAL - BASE CASE
[Y-AXIS 2012$/kWh]

But seems distant and not credible…

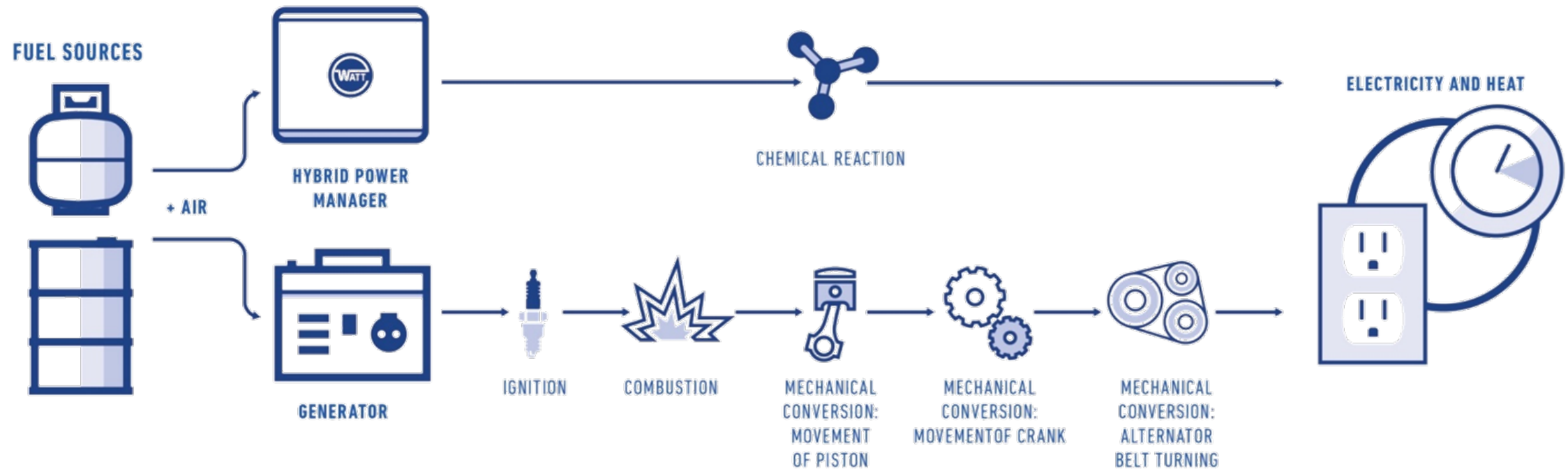# Just over the horizon? – Hydrogen Pathways

Power-to-Gas

Power-to-Fuel

How do we get from here to there?
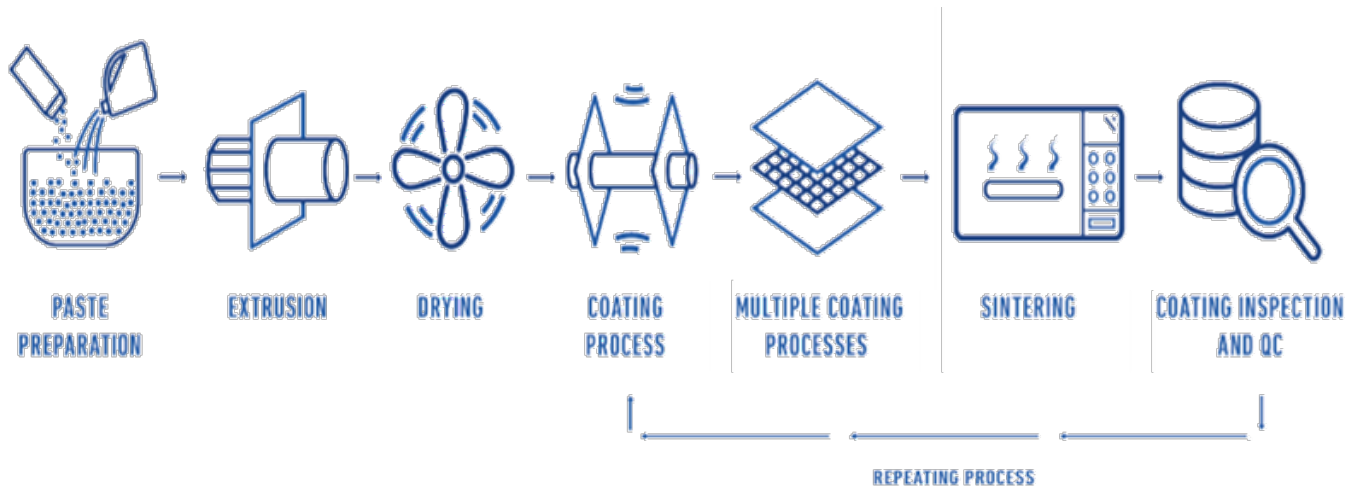
WATT FUEL CELL V. CONVENTIONAL GENERATOR

With only one step, a fuel cell directly converts fuel into usable electricity and heat through a chemical reaction. The emission is water and carbon dioxide. The result is higher efficiency, no noise and safe emissions.

WATT FUEL CELL V. CONVENTIONAL SOFC MFG

Conventional tubular SOFC manufacturing process

PASTE PREPARATION → EXTRUSION → DRYING → COATING PROCESS → MULTIPLE COATING PROCESSES → SINTERING → COATING INSPECTION AND QC

REPEATING PROCESS

Separate support formation and coating technologies require substantial staffing & significant processing times

WATT Additive Manufacturing Process (AMP)
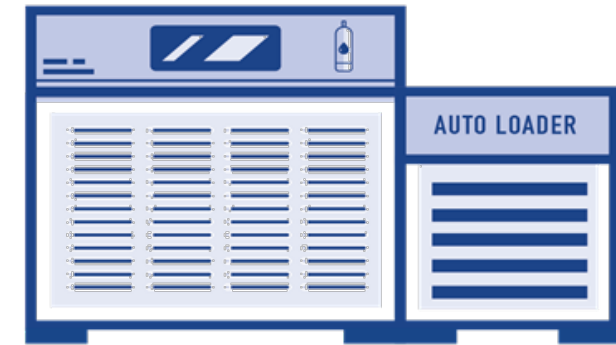
AUTO LOADER

AMP Production Printer w/ Autoloader Module
- Automated process, minimal labor

90% less time to produce SOFCs than conventional manufacturing processes

Creative Destruction is inevitable

- Expansion of additional technical solutions subject to experience curve cost reductions

- Increased economic competition for complete packages of distributed solutions

- Disintegration of traditional utility roles and natural monopolies

- Major questions:

  o How quickly will these solutions be available in volume?

  o Who will deliver them? Utilities (which ones?) vs. 3rd Party.

  o How do we manage cost shifting issues and stranded assets?

  o How can policy help or hinder this transformation?

  o What configuration does the new architecture naturally drive toward?

Thank you!