Deep Decarbonization in Practice

EVOLVED ENERGY RESEARCH

Prepared By:
Ben Haley

August 7, 2017

Contents

- Deep decarbonization defined
- Highlights and lessons learned
- Conclusions

About Evolved Energy Research

- Energy consulting firm focused on addressing key energy sector challenges posed by climate change
- Also function as the research team representing the U.S. in the Deep Decarbonization Pathways Project
- Lead developers of EnergyPATHWAYS

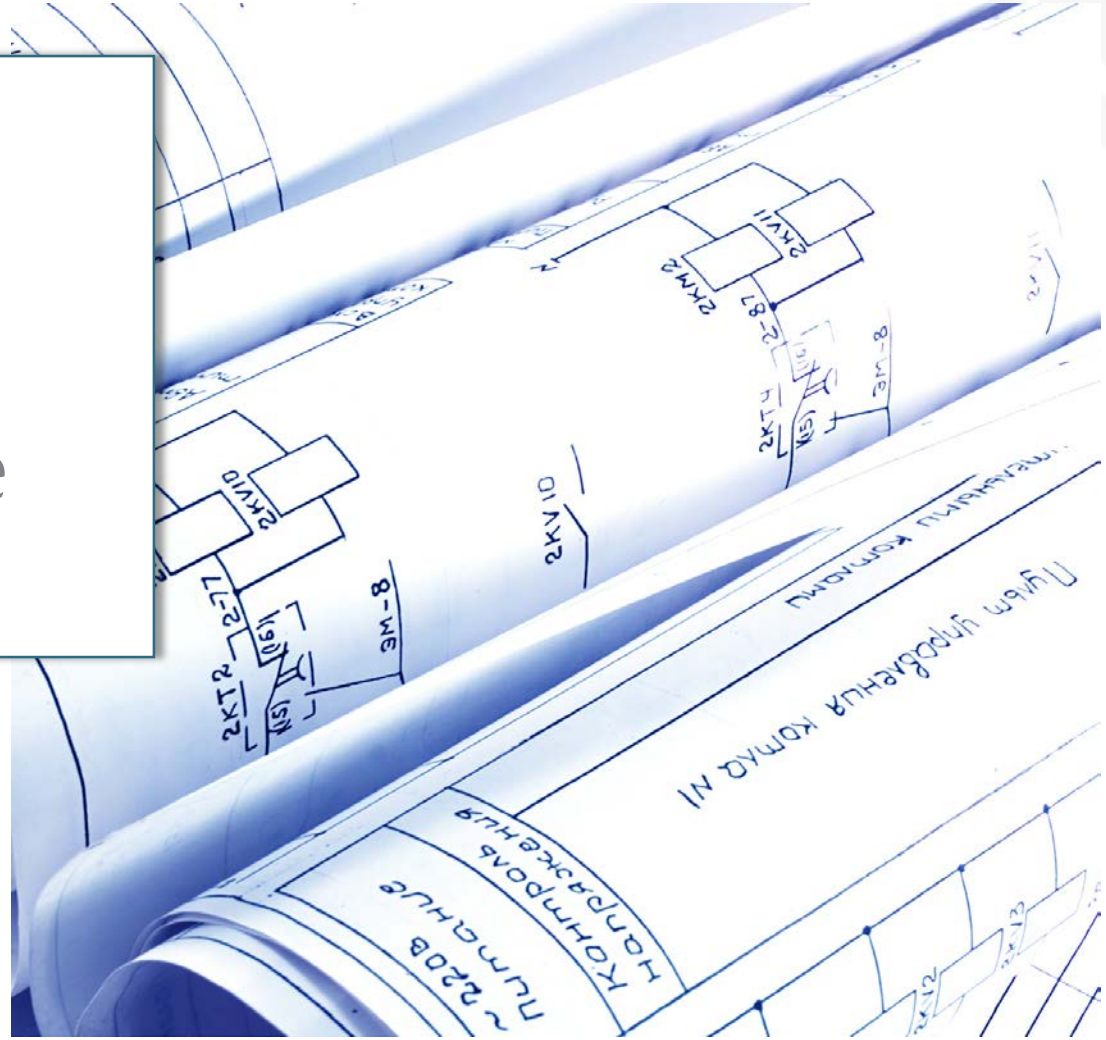
Deep Decarbonization Defined

Definitions

Deep Decarbonization:
Transformation of the energy economy consistent with keeping global warming less than 2°C

Definitions

Pathway:
Plan or blueprint to achieve deep decarbonization of the energy system



Definitions

Energy System:
The network of all energy producing, converting, delivering, or consuming infrastructure

Deep decarbonization pathways

Charting a course for climate mitigation

- Is deep decarbonization of the economy possible?
  - What **parts of the economy** can be decarbonized?
  - What are the **potential pathways** to do this?
  - What are the **best practices** in navigating the path forward?

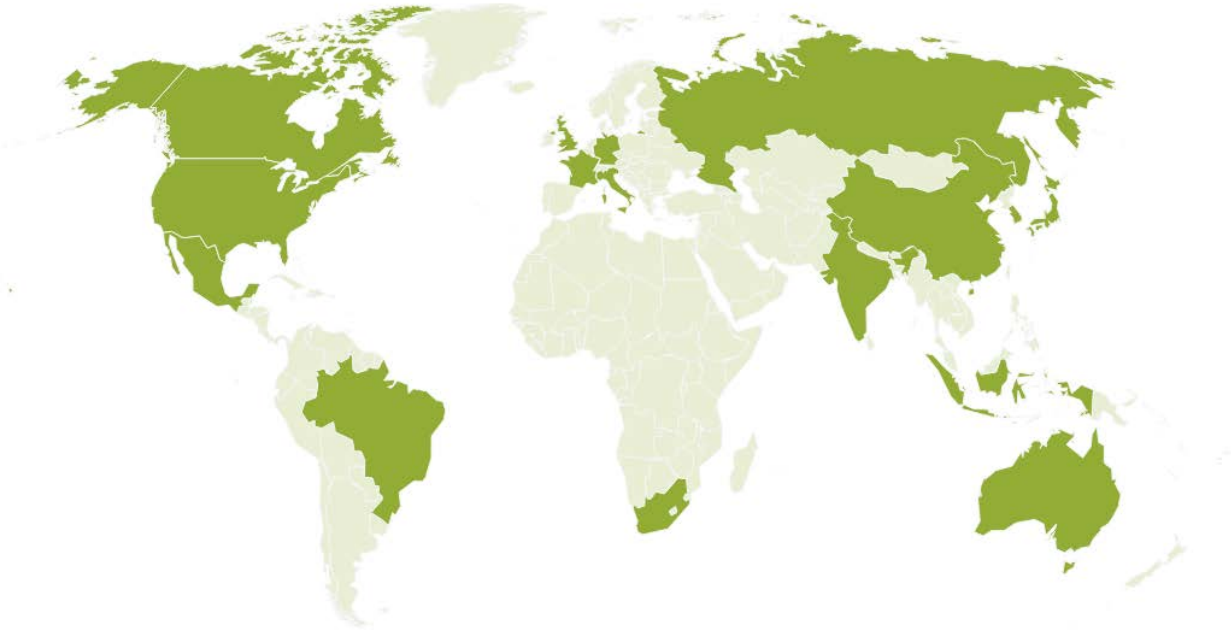
What Will the Future Look Like?

- Pathways are not a predictive exercise but instead are focused on backcasting
  - Knowing what we know now, how would we achieve a deeply decarbonized energy system and what does that mean for decisions we make today?
- Fundamentals of decarbonized systems are the same, but many choices about “how” to achieve climate targets remain
- Pathways analyses can provide a framework for communication, planning, and ultimately implementation

Who is developing pathways?

Deep Decarbonization Pathways Project

- Global project – commissioned by United Nations
  - 16 country teams participated representing ¾ of current GHG emissions
  - Compiled report on implication of national plans
  - Created a meaningful impact on the Paris accord (next slide)



http://deepdecarbonization.org/

Who is developing pathways? Cont.

Paris Climate Accord

- Article 4, Paragraph 19 to the Paris Agreement, states that *“all Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies…”*
- 175 + signatories to the agreement with long-term plans due by 2020

Who is developing these pathways? Cont.

Completed and Ongoing Public Projects

Geography	Experience
United States	• Deep Decarbonization Pathways Project (DDPP). Analyzed the technical and economic feasibility of reducing U.S. GHG emissions to 80% below 1990 levels by 2050, and the policy implications of this transition • Risky Business Project. Assessed the scale of economic opportunities and infrastructure requirements across multiple clean energy economy scenarios • National Renewable Energy Laboratory (NREL). Evaluating the implications of electrifying the U.S. economy, including the need for new generation, distribution and transmission investments, as part of NREL's POWER-UP study
California	• Southern California Gas Company (SCG). Examined the potential role of decarbonized gas distributed via the existing gas pipeline infrastructure to help meet the state's GHG goals (E3) • Governor's Office. Evaluated various deep decarbonization pathways to inform 2030 GHG target-setting (E3)
Washington State	• Office of the Governor and Office of Financial Management. Designed and evaluated deep decarbonization pathways in order to support action to meet 2050 GHG emission targets
New York State	• New York State Energy Research and Development Authority (NYSERDA). Analyzing technology pathways consistent with the state's 2030 and 2050 GHG reduction targets to inform the 2017 State Energy Plan
Midwest	• RE-AMP Network. Assisting a network of non-profits and foundations across eight Midwestern states to incorporate deep decarbonization into their analysis and strategy development
Mexico	• Sustainable Development Solutions Network. Collaborating with the Mexican DDPP research team to evaluate future high penetrations of renewable energy in the context of Mexico's energy reform and climate commitments

Highlights and Lessons Learned

Three Pillars of Deep Decarbonization

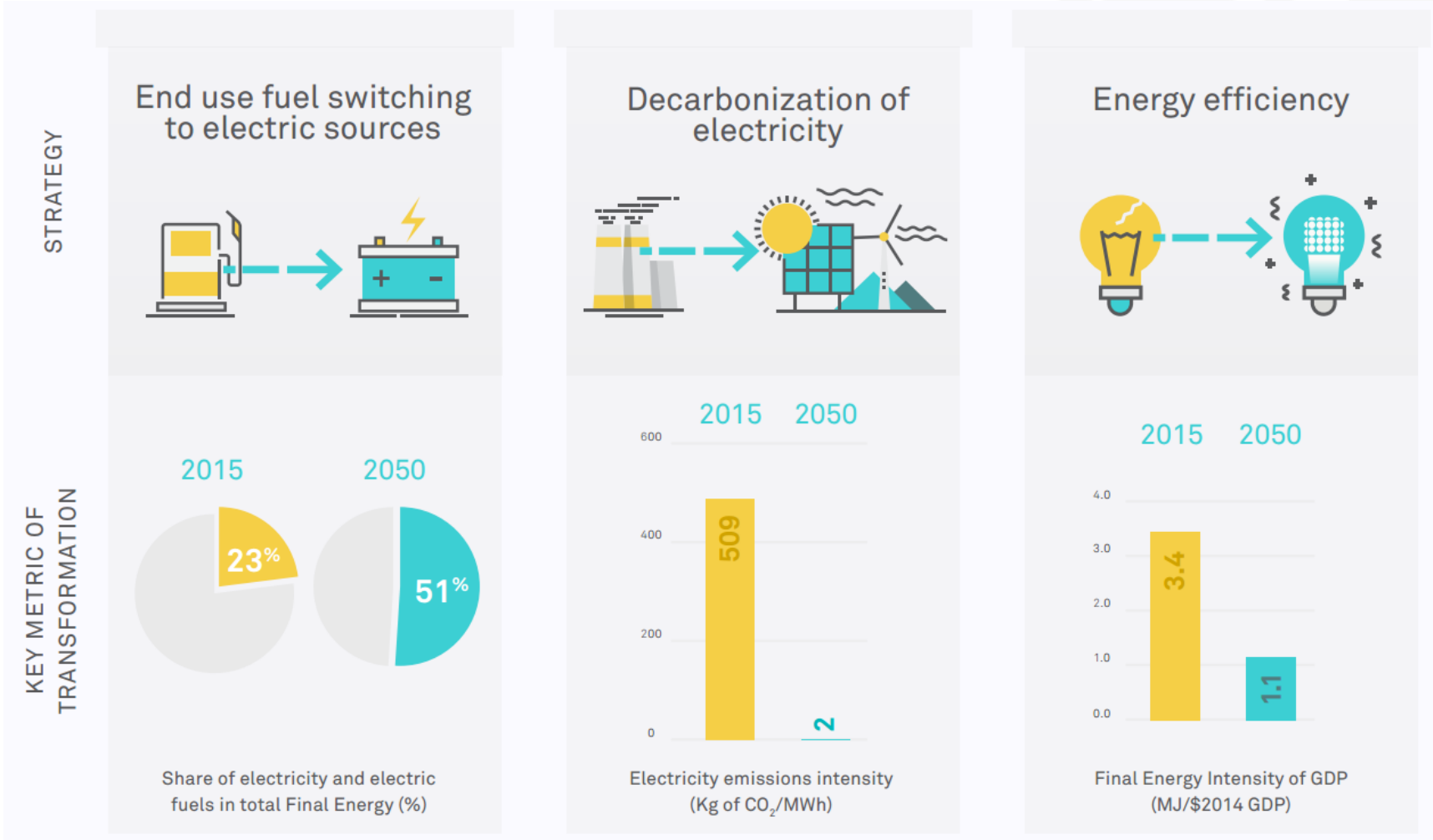
- Breadth of analyses conducted has given us a good basis to draw some high-level conclusions about what a deeply decarbonized energy system must include
- We call these the **Three Pillars** and they are:
    1. **Electrification:** Switching to electricity as final energy product for some end-uses (i.e. electric vehicles).
    2. **Energy Efficiency:** Using less energy to perform the same energy service (i.e. LED lightbulbs provide the same lighting service with less electricity)
    3. **Electricity Decarbonization:** Generating more energy from clean and renewable sources and less from fossil fuels

Three Pillars in Practice

United States

2050 U.S. Benchmarks

- 2x increase in the share of energy from electricity or electrically derived fuels
- ~99% decrease in the emissions intensity of electricity generation
- 3x drop in energy use per unit GDP

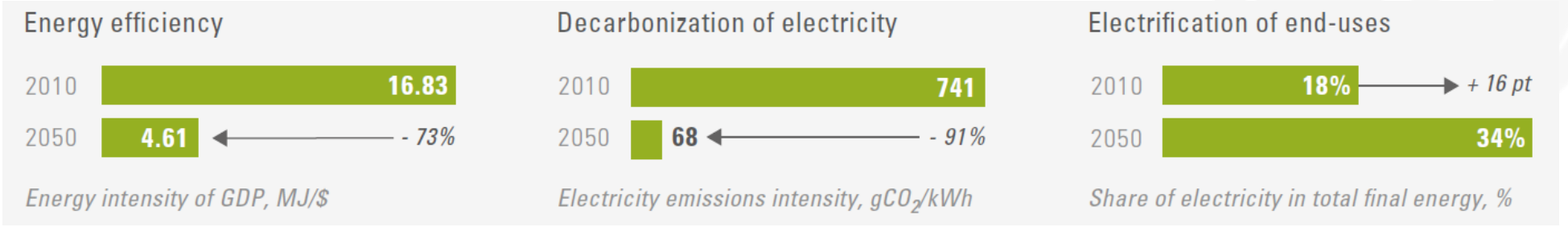


EVOLVED ENERGY RESEARCH

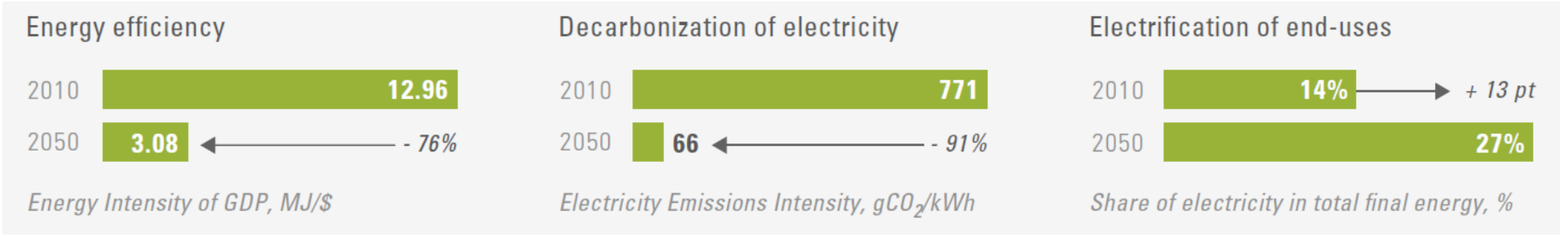
Three Pillars in Practice

China, India and United Kingdom

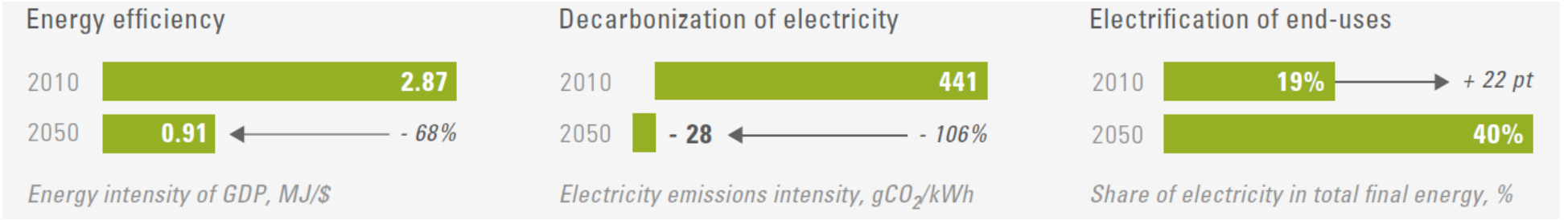
China



India

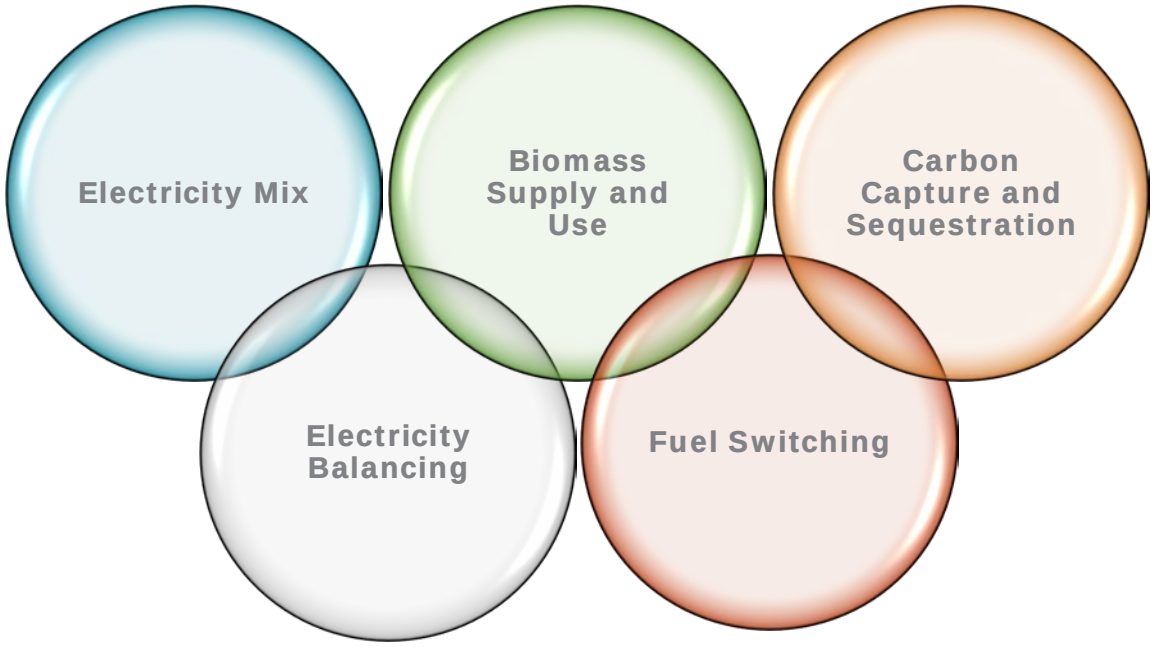


UK



Source: figures from Deep Decarbonization Pathways Project country reports (2015)

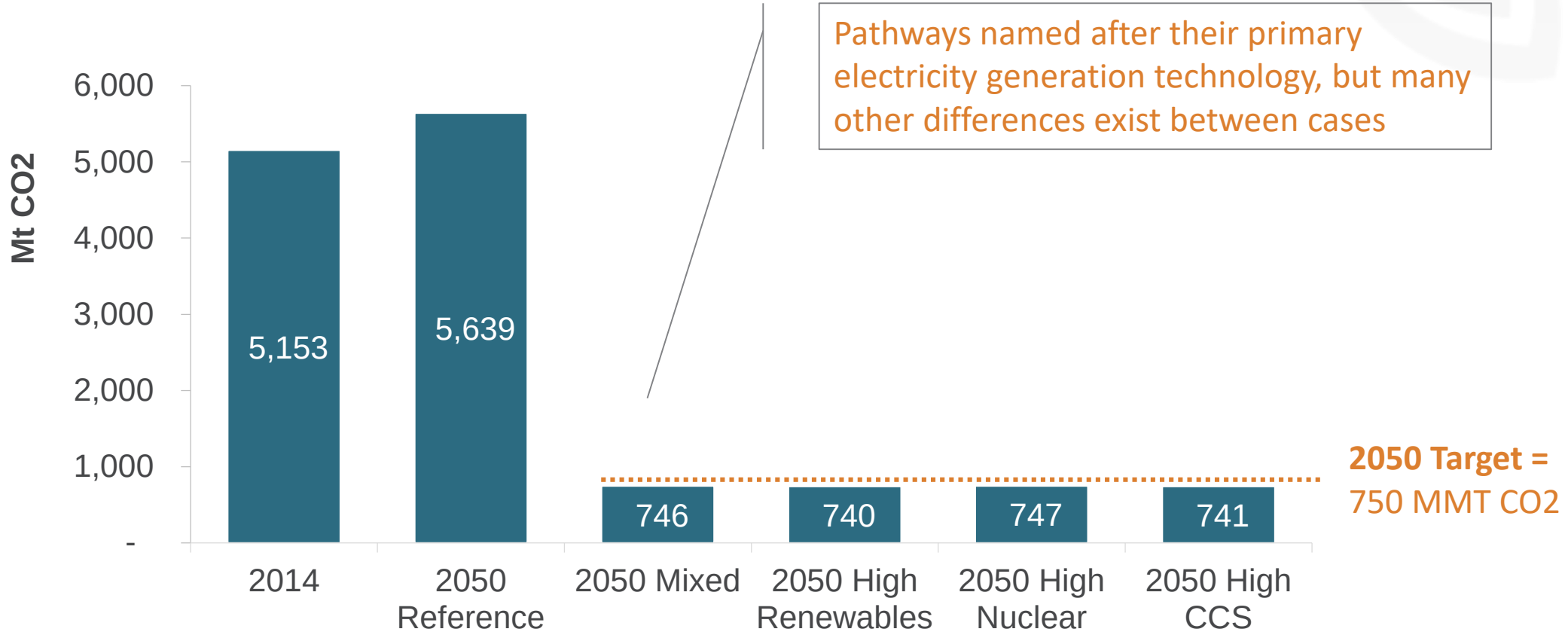
Five Elements of Deep Decarbonization



- While the energy systems have very concrete similarities, the options for achieving them allows for flexibility which reflects
  - Resource endowments
  - Societal and cultural preferences
  - Air quality considerations
  - Equity priorities
  - Regulatory regimes

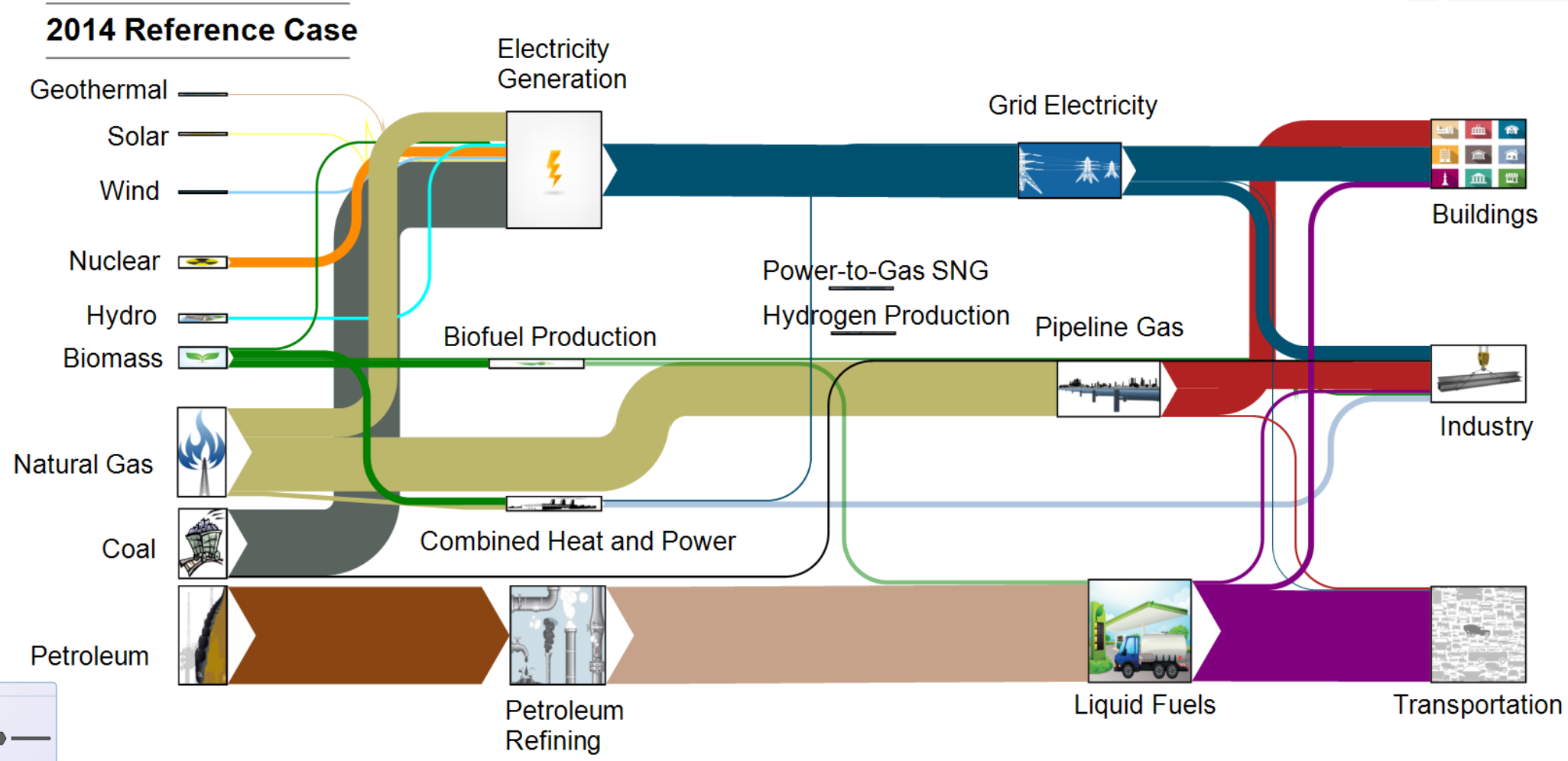
Multiple Feasible Technology Pathways Exist

Four scenarios that reach per capita energy emissions of 1.7 tonnes per person



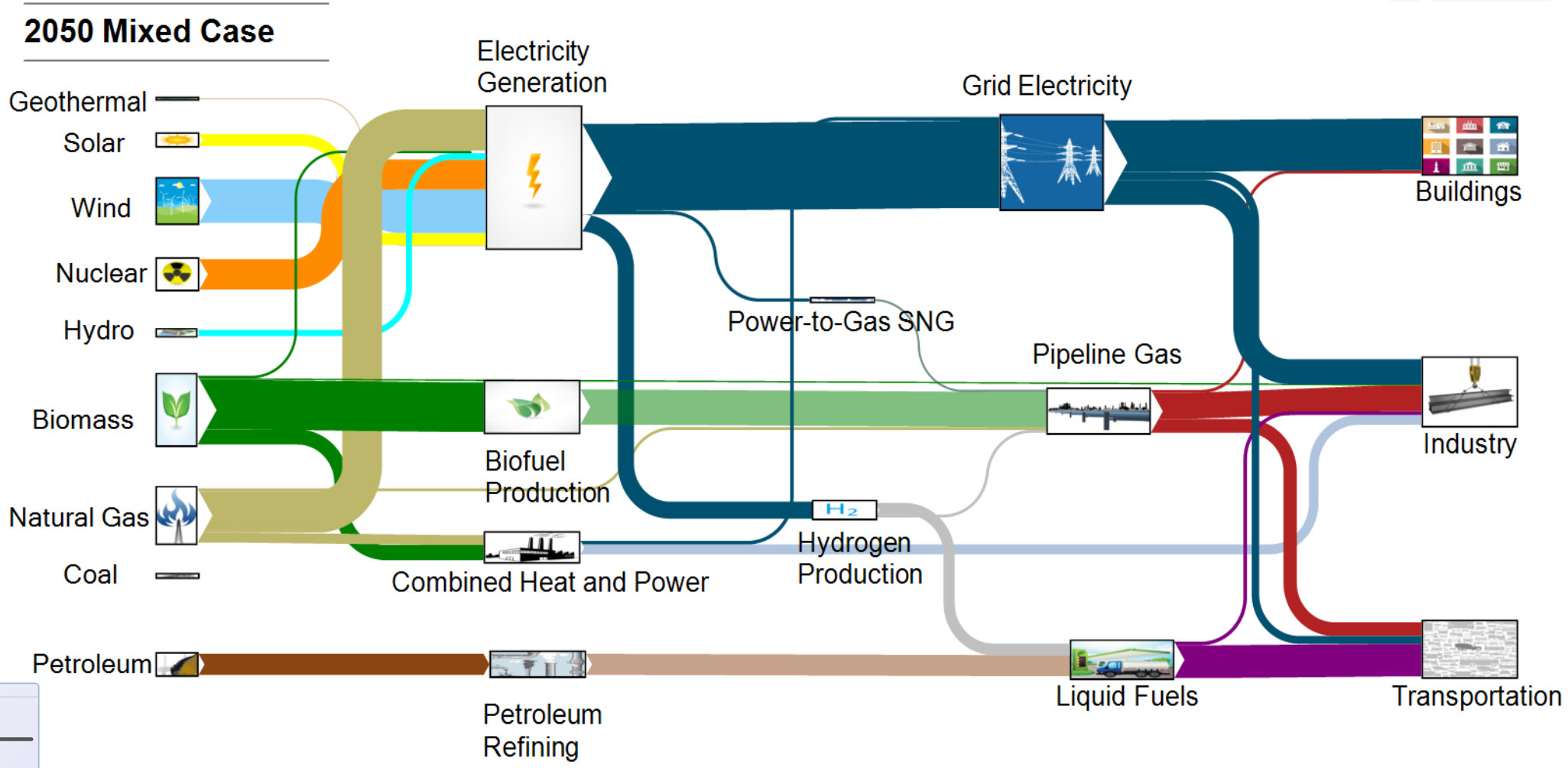
Current Energy System

U.S.



Deeply Decarbonized Energy System

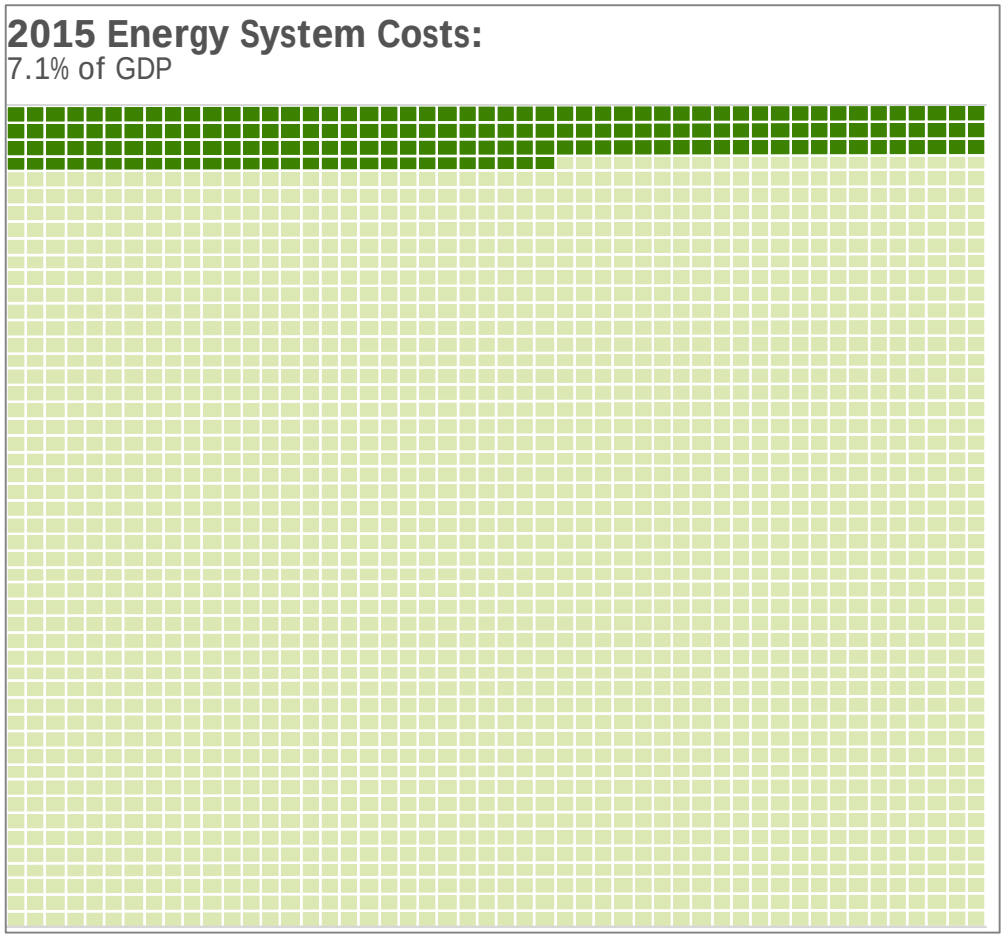
U.S



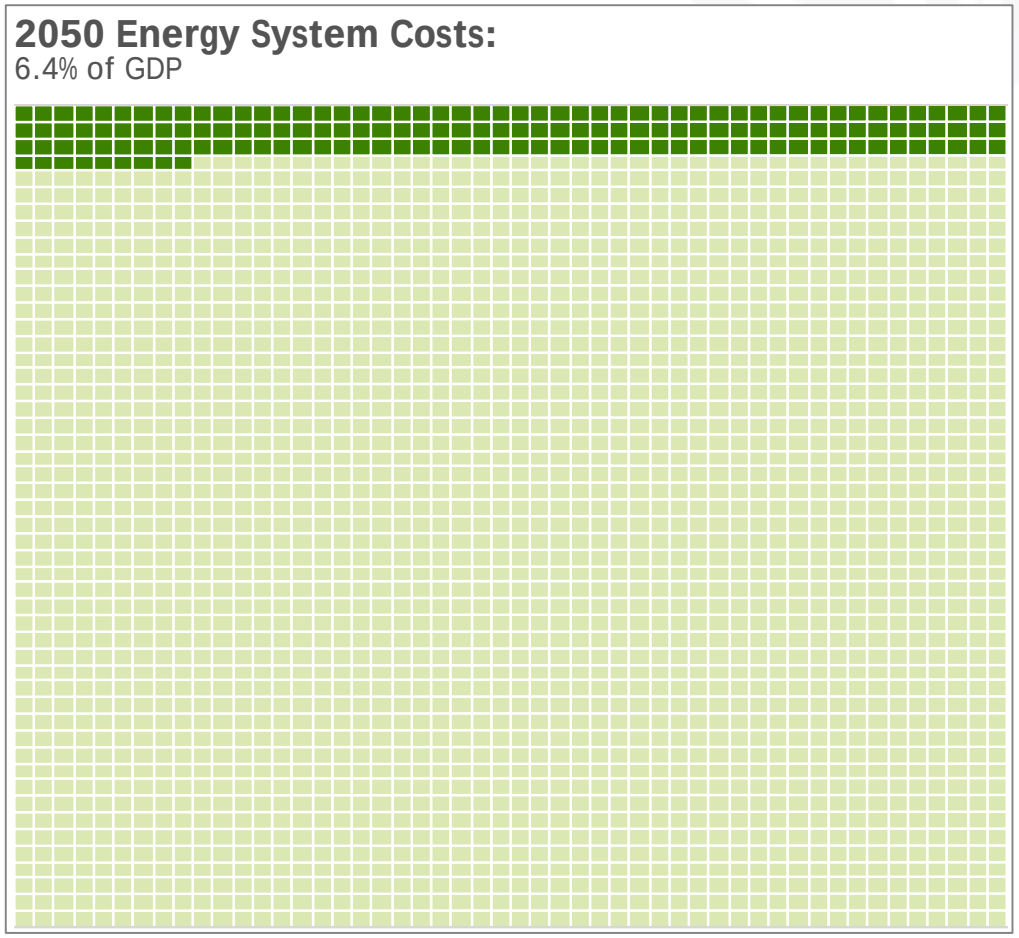
Net Energy System Costs

% of U.S. GDP for the Mixed Case

2015 Energy System Costs:
7.1% of GDP



2050 Energy System Costs:
6.4% of GDP



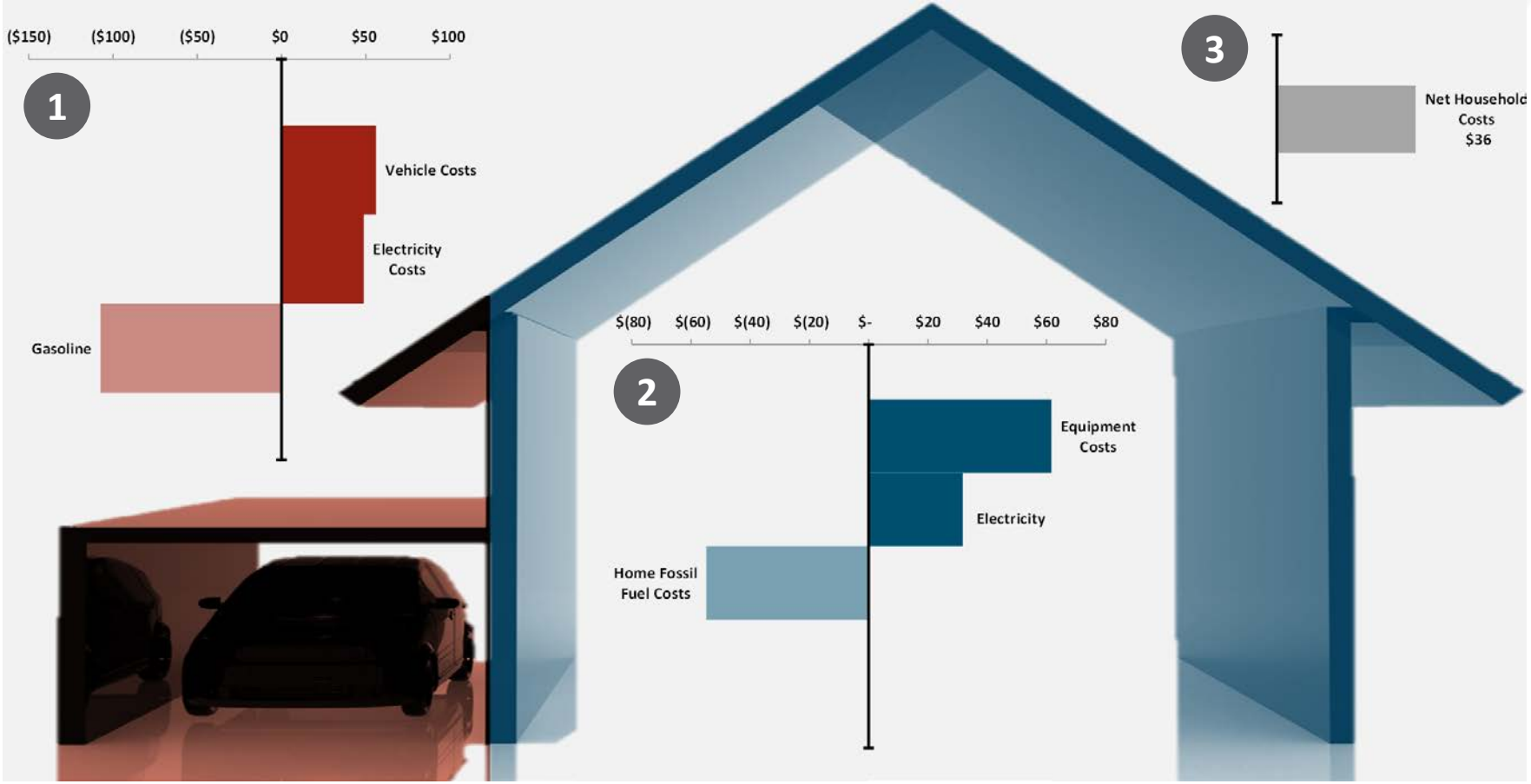
Change in Consumer Costs

Monthly net costs per US household, 2050

Net Household Cost Increase = $36/month

costs in $2014

1. Consumers pay a premium for an electric vehicle and electricity, but *less* on gasoline
2. Consumers pay a premium for efficient equipment and decarbonized fuel but *less* on fossil fuel
3. Net household cost impact is small, as the incremental cost of equipment is offset by less fossil fuel expenditures



EVOLVED ENERGY RESEARCH

Conclusions

- Ambitious economy wide deep decarbonization by 2050 is possible
- Deep decarbonization of one sector alone will not be sufficient to meet GHG reduction goals
- Multiple pathways exist to achieve deep decarbonization using existing technology
- Imperative to stay flexible – more pathways may appear as technology changes
- Achieving deep decarbonization requires collaborative, multi-sector action

THANK YOU

2443 Fillmore Street, No. 380-5034
San Francisco, CA, 94115

(415) 580-1804

info@evolved.energy

www.evolved.energy

EVOLVED
ENERGY
RESEARCH