



The Case for Fuel Diversity



Thomas Manuel Ortiz, Ph.D., P.E.
January 6, 2023



Sole reliance on an aging electric grid to provide 100% of critical energy services is dangerous

Fuel diversity—leveraging all feasible low carbon energy sources and delivery systems—**enhances safety and security**



“A nearly weeklong winter storm blasting much of the US has plunged temperatures to life-threatening lows, brought blizzards and floods, and left more than a quarter million people without power on Christmas Day, CNN reported.”



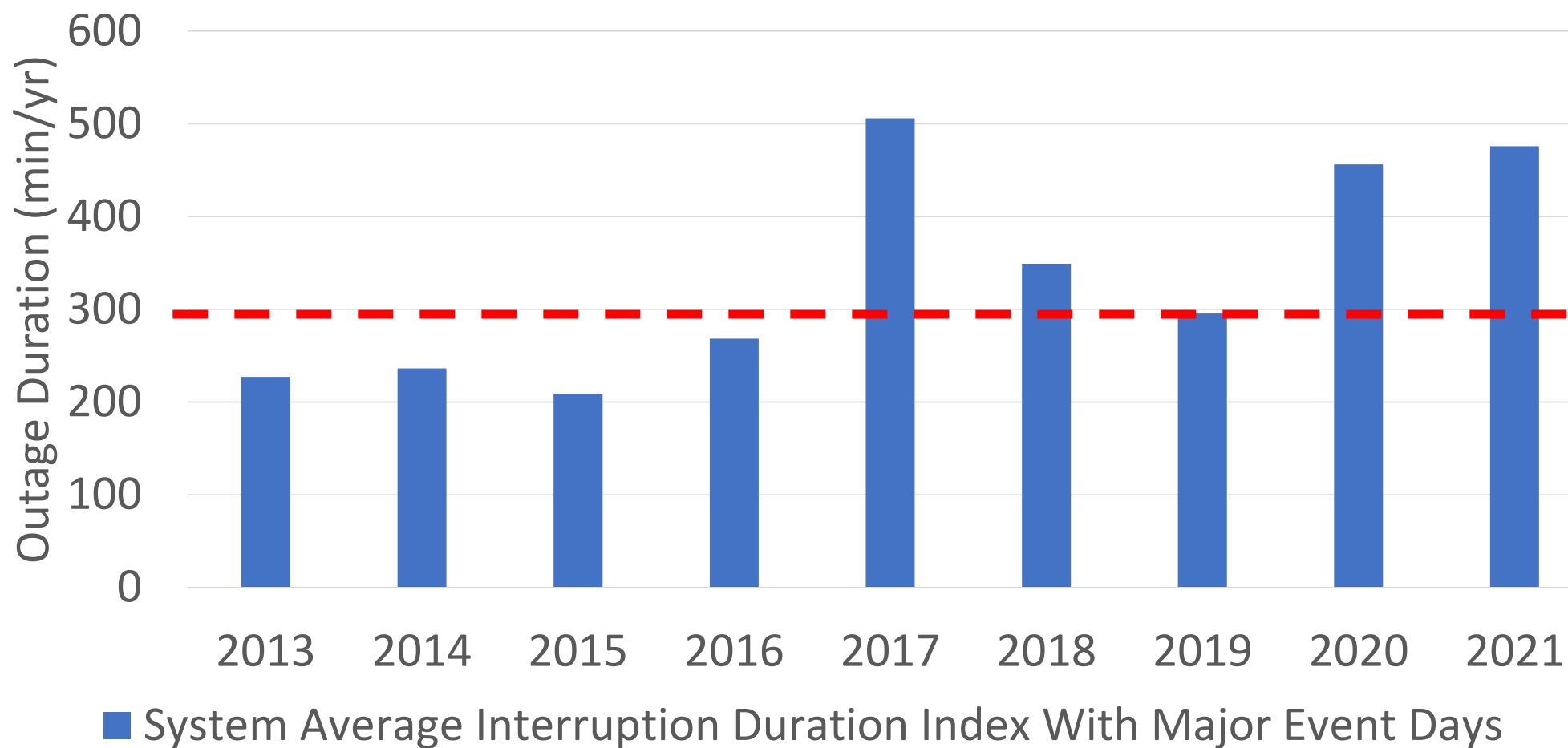
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Prolonged winter storm causes at least 35 deaths and leaves thousands without power

By Nouran Salahieh, CNN, CNNWire
Sunday, December 25, 2022

“At least 35 deaths have been attributed to dangerous weather conditions since Wednesday, and some residents in the Northeast are spending the holiday without sufficient heat or hot water as extremely cold temperatures persist.”

The average duration of power outages is increasing



Source: US EIA

The cost to create the “smart grid of the future” ranges from **\$1 - \$7 trillion**.

Compare this to the roughly \$8 trillion spent on wars in Iraq and Afghanistan over a *20 year period*. Who will pay for all of this?

Only three options:

1. Increased taxation
2. Rising national debt
3. Ratepayer charges



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Creaky U.S. power grid threatens progress on renewables, EVs

Wildfires and other natural disasters increasingly cause dangerous outages, exposing weaknesses in the U.S. electric grid. The network faces increasing electric cars. REUTERS/Mike Blake

The nation’s transmission network, plagued by outages and increasingly severe weather, needs a trillion-dollar overhaul to handle the Biden administration’s promised clean-energy revolution. No one is taking charge of that problem.

Critical infrastructure takes decades to upgrade in-place

Consider the history of British rail transport:

(Imagine trying to restore an antique car with the engine running...)

1830 – Opening of Liverpool & Manchester Railway

1855 – Rail capital stock comprises 30% of UK GDP

1892 – Transformation of 20,000 mi of track to narrow gauge completed



THE BURIAL OF THE "BROAD-GAUGE."

MAY 23, 1892.

[“Drivers of Broad-Gauge Engines wandering disconsolately about with their engine-lamps in their hands; followed by their firemen with pick and shovel over their shoulder, waiting in anxious expectation of the time when that new-fangled machine, a narrow-gauge engine, should come down a day or two after.”—*Times' Special at Plymouth on Death of Broad Gauge.*]

Not a whistle was heard, not a brass bell-note,
As his corse o'er the sleepers we hurried;
Not a fog-signal wailed from a husky throat,
O'er the grave where our "Broad-Gauge" we buried.

We buried him darkly, at dead of night,
The sod with our pickaxes turning,
By the danger-signal's ruddy light,
And our oil-lamps dimly burning.

No useless tears, though we loved him well!
Long years to his fire-box had bound us.
We fancied we glimpsed the great shade of
BRUNEL.

In sad sympathy hovering round us.
Few and gruff were the words we said,
But we thought, with a natural sorrow,
Of the Narrow-Gauge foe of the Loco. just dead.

We should have to attend on the morrow.
We thought, as we hollowed his big broad bed,
And piled the brown earth o'er his tunnel,
How his foe o'er the Great-Western metals would tread,
Shrieking triumph through cutting and tunnel.

Lightly they'll talk of him now he is gone,
For the cheap "Narrow Gauge" has out-stayed him,
Yet BULL *might* have found, had he let it go on,
That BRUNEL's Big Idea would have paid him!

But the battle is ended, our task is done;
After forty years' fight he's retiring.*
This hour sees thy triumph, O STEPHENSON;
Old "Broad Gauge" no more will need firing.

The "Dutchman" must now be "divided in two"—

Well, well, they shan't mangle or mess *you!*
Accept the last words of friends faithful, if few:—
"Good-bye, poor old Broad-Gauge, God bless you!" †

Slowly and sadly we laid him down.
He has filled a great chapter in story.
We sang not a dirge—we raised not a stone,
But we left the "Broad Gauge" to his glory!

* The Royal Commission appointed to inquire into the uniformity of railway gauges, presented their report to Parliament on May 30, 1846.

† Words found written on one of the G.-W. rails.

TO A DEAR YOUNG FEMINE FRIEND, WHO
SPELT "WAGON" AS "WAGGON."
BAD spelling? Oh dear no! So tender, she
Wished that the cart should have an extra
"gee."

Now, compare with the task of upgrading the US electric grid

Feds order review of power-grid security after attacks

Federal regulators have ordered a review of security standards at the nation's far-flung electricity transmission network

By MATTHEW DALY Associated Press
December 15, 2022, 4:53 PM

Not only do we need large amounts of new transmission capacity, but it needs to be totally redesigned to withstand multiple, unprecedented operational and security challenges.

“Grid security experts have said the attacks demonstrate anew the vulnerability of the nation's electric grid, which includes more than **50,000 substations** and more than **700,000 miles** of transmission lines.”

THE WHITE HOUSE



If we invested \$12.5 billion annually, we would need **between 80 and 560 years** to complete all of the estimated **\$1 – \$7 trillion** in upgrades to the US electric grid.

This constraint is not being adequately debated in building code discussions.

Today, the Department of Energy (DOE) announced ↗ that first-round applications are open for competitive grants under the Grid Resilience and Innovation Partnership Programs ↗, which total **\$10.5 billion** in available funding, as well as the **\$2.5 billion** Transmission Facilitation Program ↗. Funded by the President's Bipartisan Infrastructure Law, these programs together represent the largest single direct federal investment in critical transmission and distribution infrastructure.

An estimated 70 percent of the nation's transmission lines are over 25 years old, and this aging infrastructure makes American communities, critical infrastructure, and economic interests vulnerable. New and upgraded transmission lines deliver electricity to where it's needed,

And even if we can find all of this money...

“Dependence on critical minerals is expected to surge over the coming decades, **especially as the world transitions to renewable energy technologies.**”

“**Research and development that could** lead to the technologies needed to safely and economically **expand and recover domestically sourced supplies is limited**”

“Limited domestic infrastructure and capacity **prevents large-scale recovery**”



U.S. Government Accountability Office

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Critical Mineral Shortages Could Disrupt Global Supply Chains

Posted on June 21, 2022

Geopolitical Competition for Critical Minerals Will Pose Major Challenges for Energy Storage and EV Production

ENERGYWIRE

Raw lithium exports banned in Zimbabwe as demand soars

Mining companies that are building processing plants will be excluded from the directive, officials said.

BY: **BLOOMBERG** | 12/21/2022 07:10 AM EST

ENERGYWIRE | Zimbabwe has banned the export of unprocessed raw lithium with immediate effect as part of efforts to have the key raw material in electric-vehicle batteries processed locally.

“...the sharply increased variability of [marginal values of electricity (MVE)] compared to today means that setting wholesale and retail prices equal to MVEs would likely impose politically intolerable risks at both levels.”

And power markets may struggle to cope as wind/solar share grows



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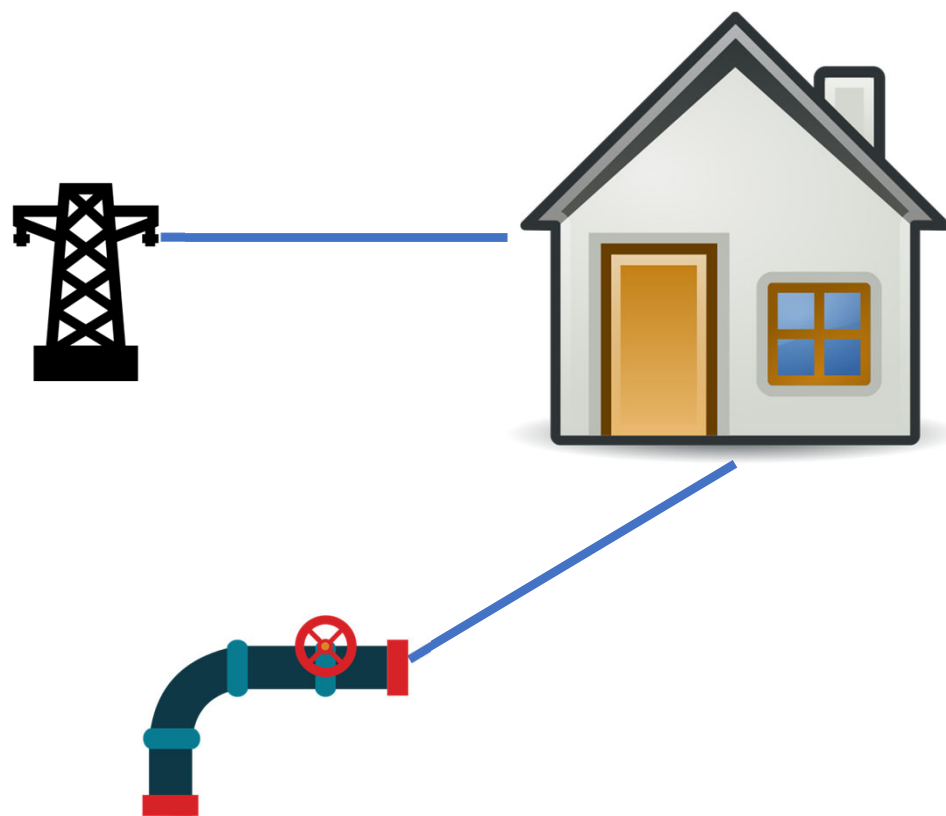
Electricity Pricing Problems in Future Renewables-Dominant Power Systems

Dharik S. Mallapragada, Cristian Junge, Cathy Wang,
Hannes Pfeifenberger, Paul L. Joskow, and
Richard Schmalensee

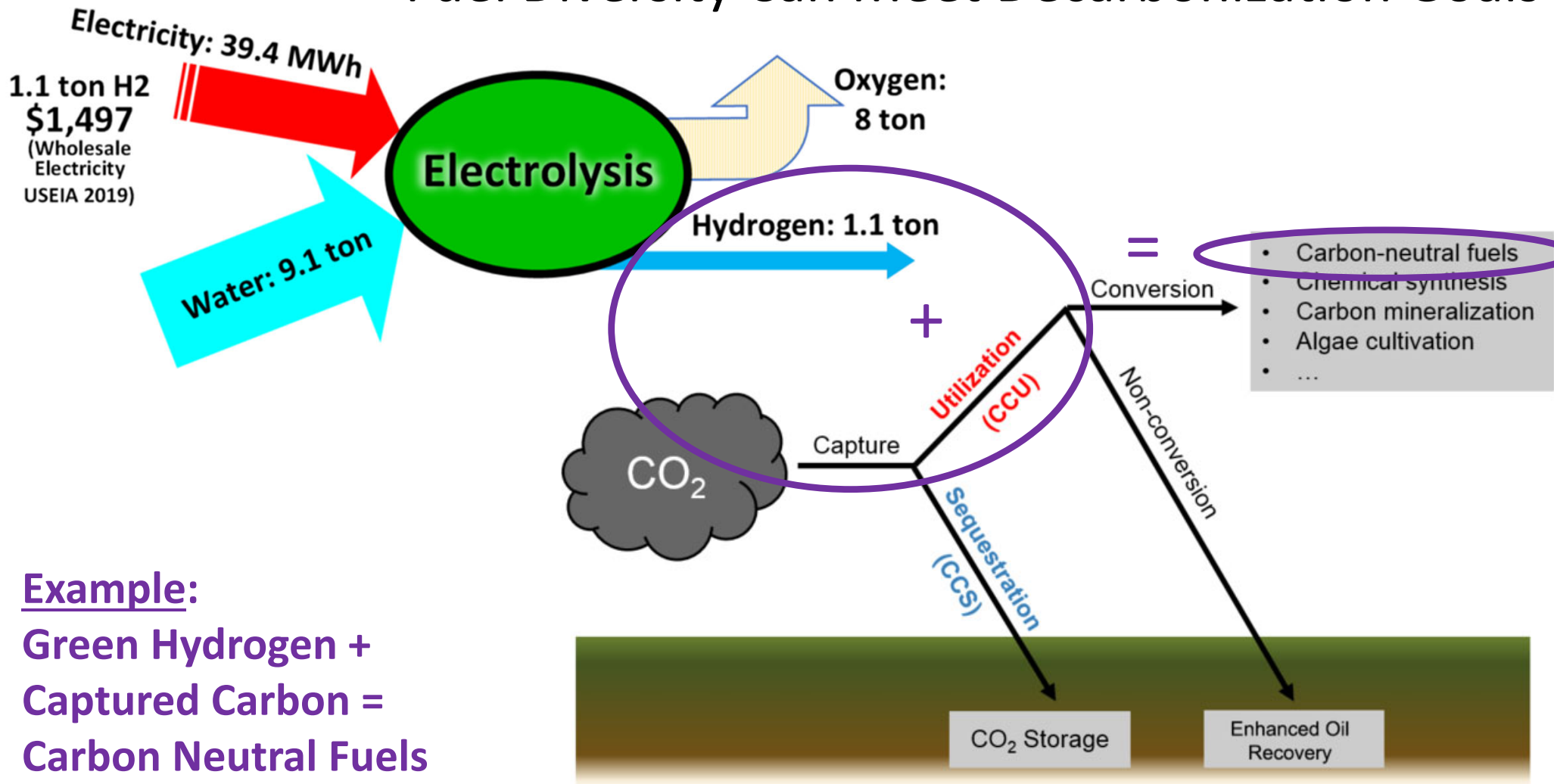
An All-Electric Building Mandate Will Reduce Energy Security and Resilience

Moreover, even **mandatory electric readiness and storage** code sections are a de facto subsidy to the rooftop solar and lithium-ion battery industries which **disincentivize energy source diversity**.

Any energy distribution system can fail, and **encouraging multiple layers of independent energy delivery** reduce the chance that a building will be left both dark and cold in emergencies.



Fuel Diversity Can Meet Decarbonization Goals



Carbon Neutral Fuels Can Reduce Electric Grid Risk

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OCTOBER 17, 2019

Stanford researchers create new catalyst that can turn carbon dioxide into fuels

A new process shows promise in turning the greenhouse gas carbon dioxide back into usable fuels, and yields four times as much fuel as previous approaches.



Upshot: **A circular economy** that reuses captured carbon and hydrogen made from seawater to produce sustainable methane, propane, methanol, even long-chain hydrocarbons—familiar, convenient fuels needing **no new infrastructure**.



Multifunctional Catalyst Combination for the Direct Conversion of CO₂ to Propane

Adrian Ramirez, Pierfrancesco Ticali, Davide Salusso, Tomas Cordero-Lanzac, Samy Ould-Chikh, Christian Ahoba-Sam, Aram L. Bugaev, Elisa Borfecchia, Sara Morandi, Matteo Signorile, Silvia Bordiga,* Jorge Gascon,* and Unni Olsbye*

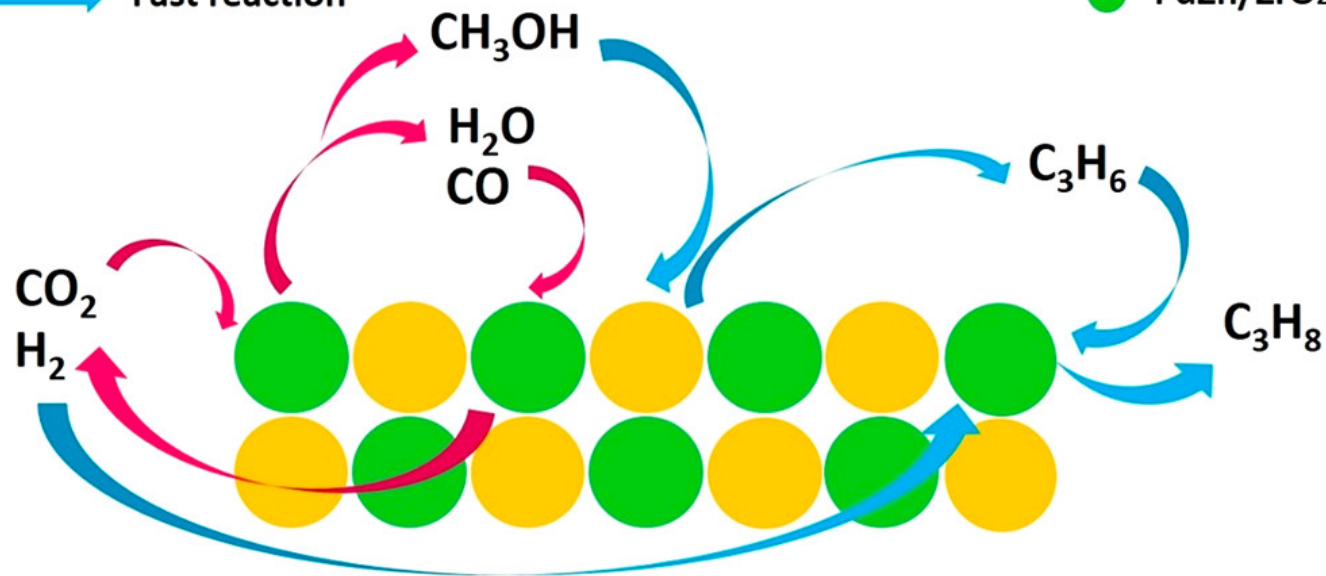


Cite This: *JACS Au* 2021, 1, 1719–1732

 Equilibrium
 Fast reaction

 SAPO-34
 PdZn/ZrO₂

Synthetic propane is an ideal green energy carrier due to its easy transport, storage and household use

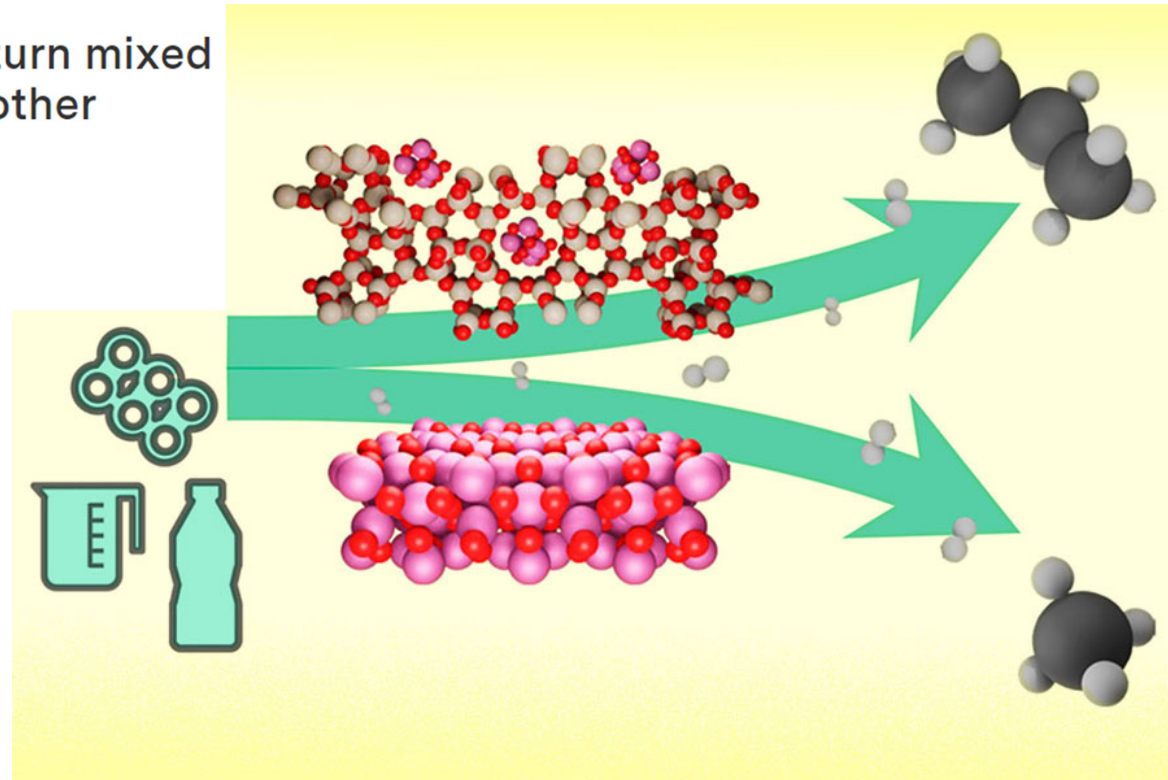


New process could enable more efficient plastics recycling

Cobalt-based catalysts could be used to turn mixed plastic waste into fuel, new plastics, and other products.

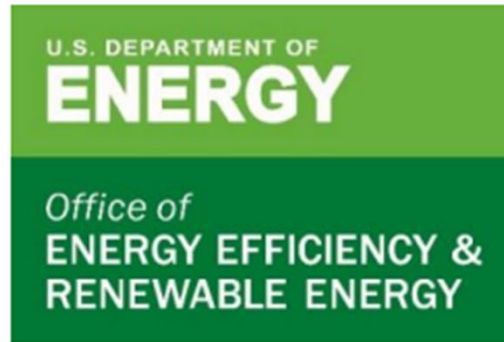
David L. Chandler | MIT News Office
October 6, 2022

Sustainable hydrocarbon fuels can also help alleviate the growing challenge of plastic waste accumulation



And natural gas emissions can be reduced by blending hydrogen

“...plans to construct a pipeline grid with a length of over 900 kilometres by 2030, **mostly by retrofitting existing natural gas transport infrastructure.**”



HyBlend: Opportunities for Hydrogen Blending in Natural Gas Pipelines

15 Dec 2022, 13:43 [Benjamin Wehrmann](#)

Construction of Europe's first hydrogen pipeline network to begin in Germany

Clean Energy Wire

Therefore, *carbon neutrality* should be the goal of emissions reduction programs. *Account for lifecycle emissions.*



GREENHOUSE
GAS PROTOCOL

ABOUT

STANDARDS

GUIDANCE

CALCULATION
TOOLS

EVENTS

GHG Protocol supplies the world's most widely used greenhouse gas accounting standards.

The standards below are designed to provide a framework for businesses, governments, and other entities to measure and report their greenhouse gas emissions in ways that support their missions and goals.

In 2016, 92% of Fortune 500 companies responding to the CDP used GHG Protocol directly or indirectly through a program based on GHG Protocol. It provides the accounting platform for virtually every corporate GHG reporting program in the world.

Building codes have a safety mandate—first and foremost. **Overreliance on electrification as the sole source of energy will create a single point of failure in the built environment.**

BUILDINGSAFETYJOURNAL



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APRIL 30TH, 2018

by [Tara Lukasik](#)

DEEP DIVES



Throughout the United States and around the world, people have sustained injuries, death and economic loss because of unsafe buildings and systems. These losses are successfully minimized through the application of, and ongoing enhancements to, building safety codes and standards and a regulatory system to administer them.

**Maintaining fuel diversity is
a commonsense method for
preventing energy insecurity.**

Gov. Abbott declares power system winterization, related funding as emergency items

by CBS Austin | Jordan Bontke | Thursday, February 18th 2021



Just ask
any
Texan



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