



Bio-Hydrogen Refueling Station



IUPUI SCHOOL OF ENGINEERING AND TECHNOLOGY
A PURDUE UNIVERSITY SCHOOL
Indianapolis

“Distributed Renewable Transportation Fuel using Materials Sourced Locally”

Peter J. Schubert, Ph.D., P.E.
Professor, Electrical and Computer Engineering
Director, Lugar Center for Renewable Energy

How NOT to Refuel Hydrogen Fuel Cell Vehicles

1. Do not use fossil fuels (natural gas or coal)
2. Do not use centralized processing & distribution
3. Do not use extremes of temperature or pressure

The IUPUI Approach is Superior

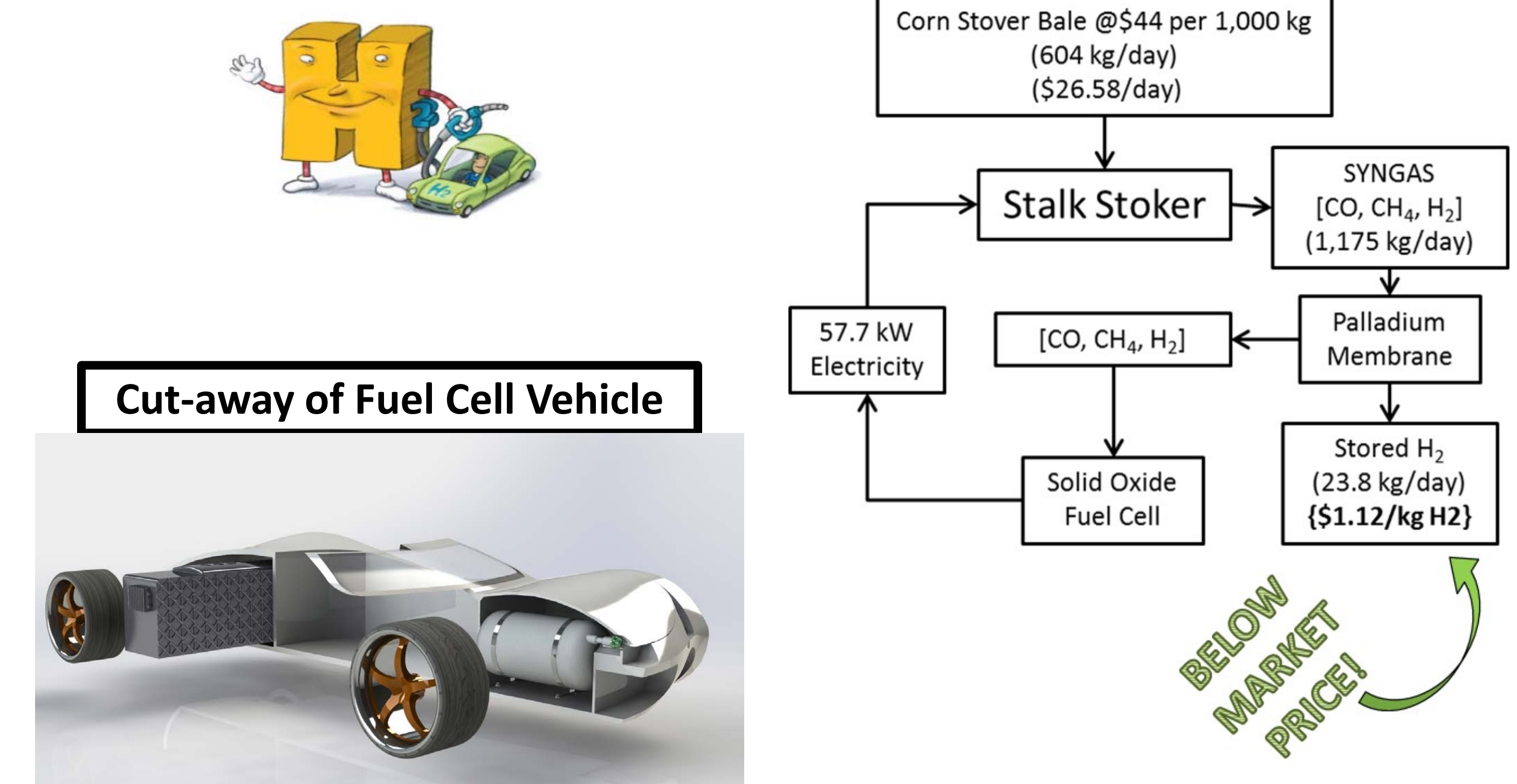
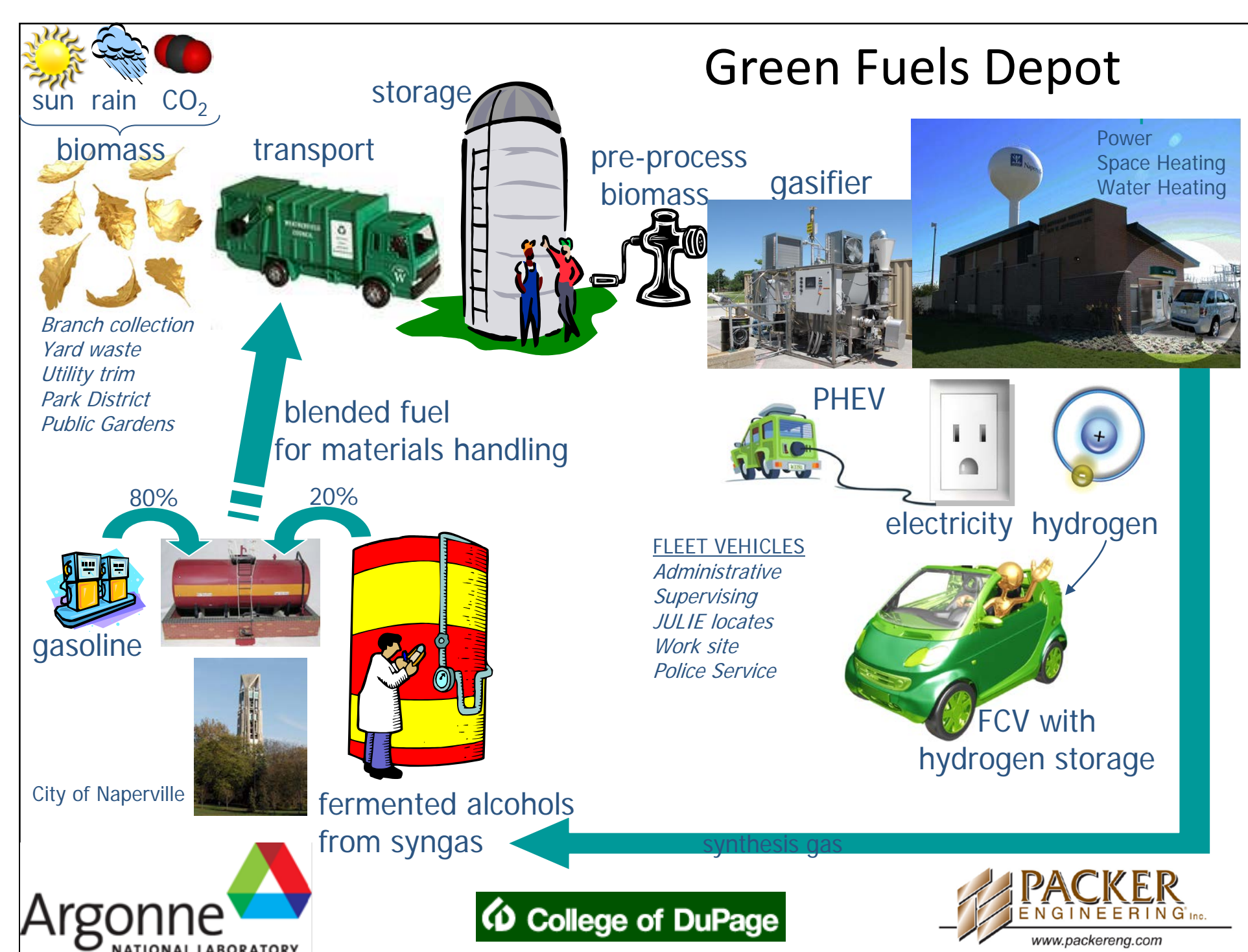
1. Uses local biomass – farms, yards, utility trimmings
2. Operate locally – use existing infrastructure
3. Store using porous silicon – like bike tire pressure.

Description

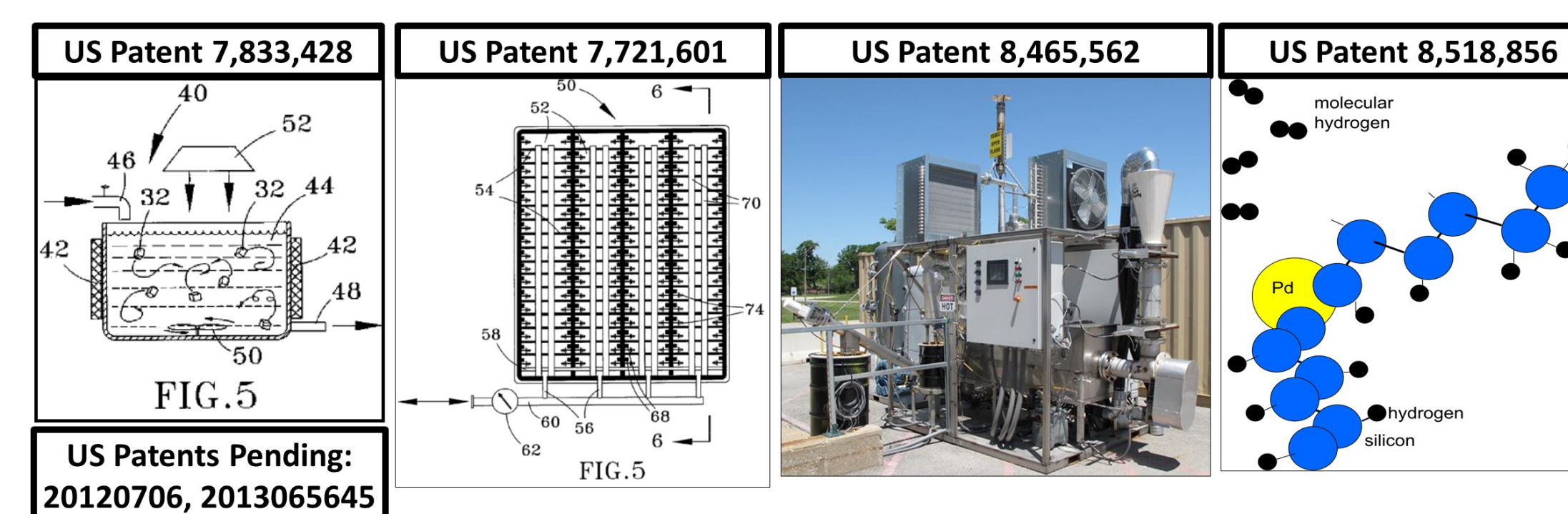
Hydrogen fuel cell cars are now available for lease and for sale. Renewable hydrogen fuel can be produced from water via electrolysis, or from biomass via gasification. Electrolysis is power-hungry with high demand from solar or wind power. Gasification, however, can be energy self-sufficient using a recently-patented thermochemical conversion technology known as Indirectly-Heated Pyrolytic Gasification. I-HPG produces a tar-free syngas from non-food woody biomass. This means the balance of plant can be small, so the overall system is economical at modest sizes. This makes it possible to produce renewable hydrogen from local agricultural residues; sufficient to create distributed refueling stations wherever there is feedstock. This work describes the specifics of a novel bio-hydrogen refueling station whereby the syngas produced has much of the hydrogen extracted with the remainder powering a generator to provide the electric power to the I-HPG system. Thus the system runs continuously. When paired with another new technology, moderate-pressure storage of hydrogen in porous silicon, there is the potential to also power the refueling operation. Such systems can be operated independently. It is even possible to design an energy self-sufficient farm where all electric power, heat, and hydrogen fuel is produced from the non-food residues of agricultural operations. No water is required, and the carbon footprint is negative, or at least neutral.

Future

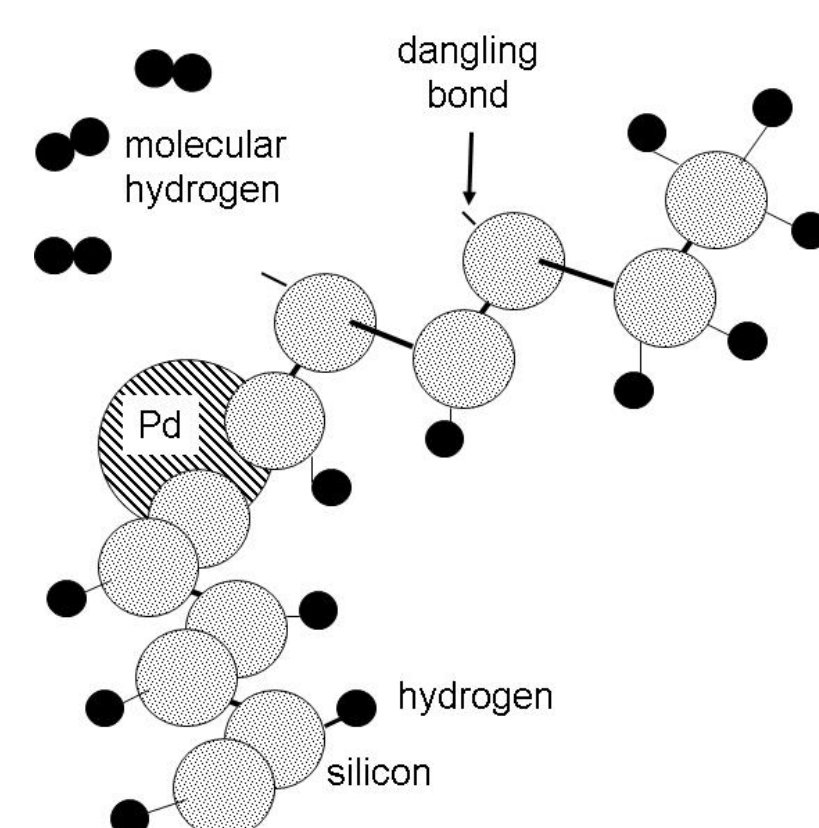
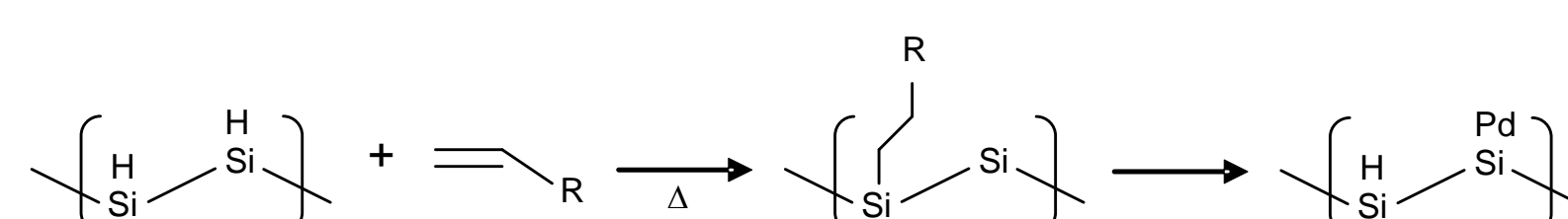
A biomass gasifier is installed and operational on campus. Hydrogen storage using porous silicon is underway. IURTC holds five US Patents on these complementary bio-hydrogen technologies. The potential for low-cost, safe, and convenient hydrogen could mean that all fuels are produced locally and have only water vapor as effluent.



Biomass to Hydrogen System



Biomass Thermochemical Conversion

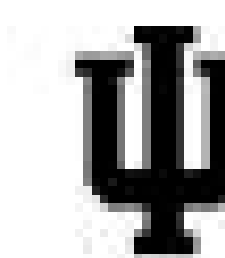


Storage in Catalytically-modified Porous Silicon

$$D = \frac{1}{z} v_s \alpha^2 \exp\left(-\frac{E_s}{kT}\right)$$

$$J_x = -D \frac{\partial n}{\partial x}$$

$$\frac{\partial n}{\partial x} = \frac{PN_A}{RT\alpha}$$



INDIANA UNIVERSITY
PURDUE UNIVERSITY
INDIANAPOLIS

About the Lugar Center for Renewable Energy

The Richard G. Lugar Center for Renewable Energy (LCRE) was established in 2007 to address the societal needs for clean, affordable, renewable energy sources while improving the nation's energy security and helping to mitigate the negative impacts of climate change.

Our primary mission is to promote research excellence in renewable energy through collaborative efforts among faculty in the disciplines of engineering, chemistry, physics, biology, and environmental affairs and public policy.

These renewable energy applications are promoted through education, civic engagement, and synergistic partnerships with industry, government labs, and local communities.

Visit our website at www.lugarenergycenter.org

