Sustainable Energy Security

Need for a Comprehensive Systematic Integrated Approach

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Disclaimer

The thoughts, ideas, and opinions expressed in this presentation are strictly personal and are NOT necessarily those of Department of Energy or that of my employer, Savannah River Nuclear Solutions, LLC. – Benjamin J. Cross

Think About It!!!

"The world that we have made as a result of the level of thinking that we have done so far, has created problems we cannot solve at the level of thinking at which we created them."

- Albert Einstein

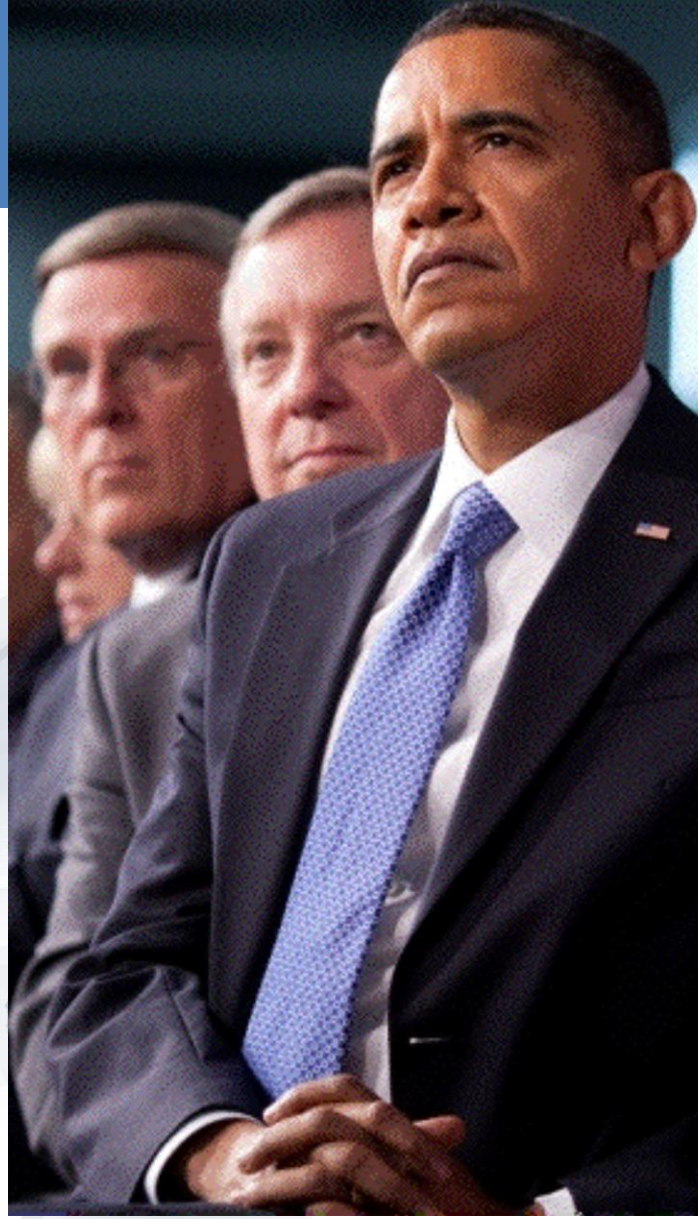
A Challenge

"I am convinced that whoever builds a clean energy economy, whoever is at the forefront of that, is going to own the 21st Century economy.

I'm convinced America can win the race.

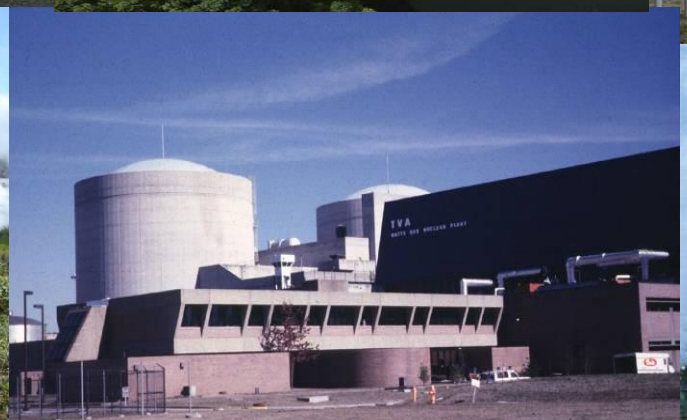
Let's get it done."

President Barack Obama
February 3, 2010



Energy Conversion Systems

Several options are available to meet energy needs



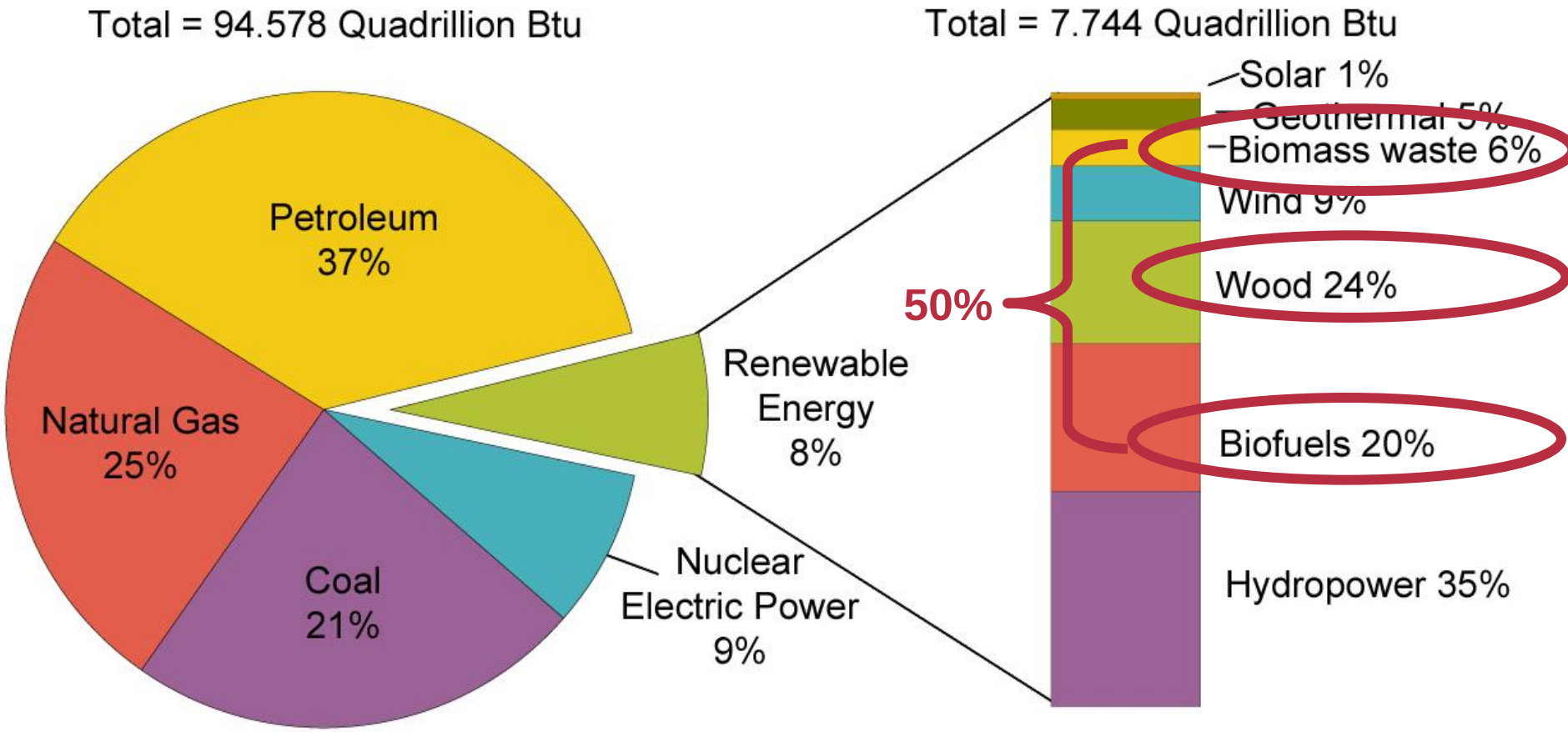
Things to remember and consider

- **Fossil is old biomass with terrestrial contamination**
- **Fossil and biomass fuels are hydrocarbon fuels**
- **Hydrocarbons, as fuels and specialty chemicals, will be needed forever**
- **Humans likes to bury or ignore their "waste" and problems**
- **Don't fight nature or the laws of physics, use them to your advantage**
- **Nature recycles**
- **Work together versus independently**
- **Right fuel for the right job (max value)**

Current U.S. Energy Situation

- Oil imports are approaching **70%**
- **Oil is the majority** of the trade deficit
  - ~$10 trillion since 1976
- Imports very small amount of electricity
- Energy efforts primarily focused on electricity
  - Electric centric
- Lacks comprehensive plan (roadmap) and sense of urgency to obtain sustainable energy security

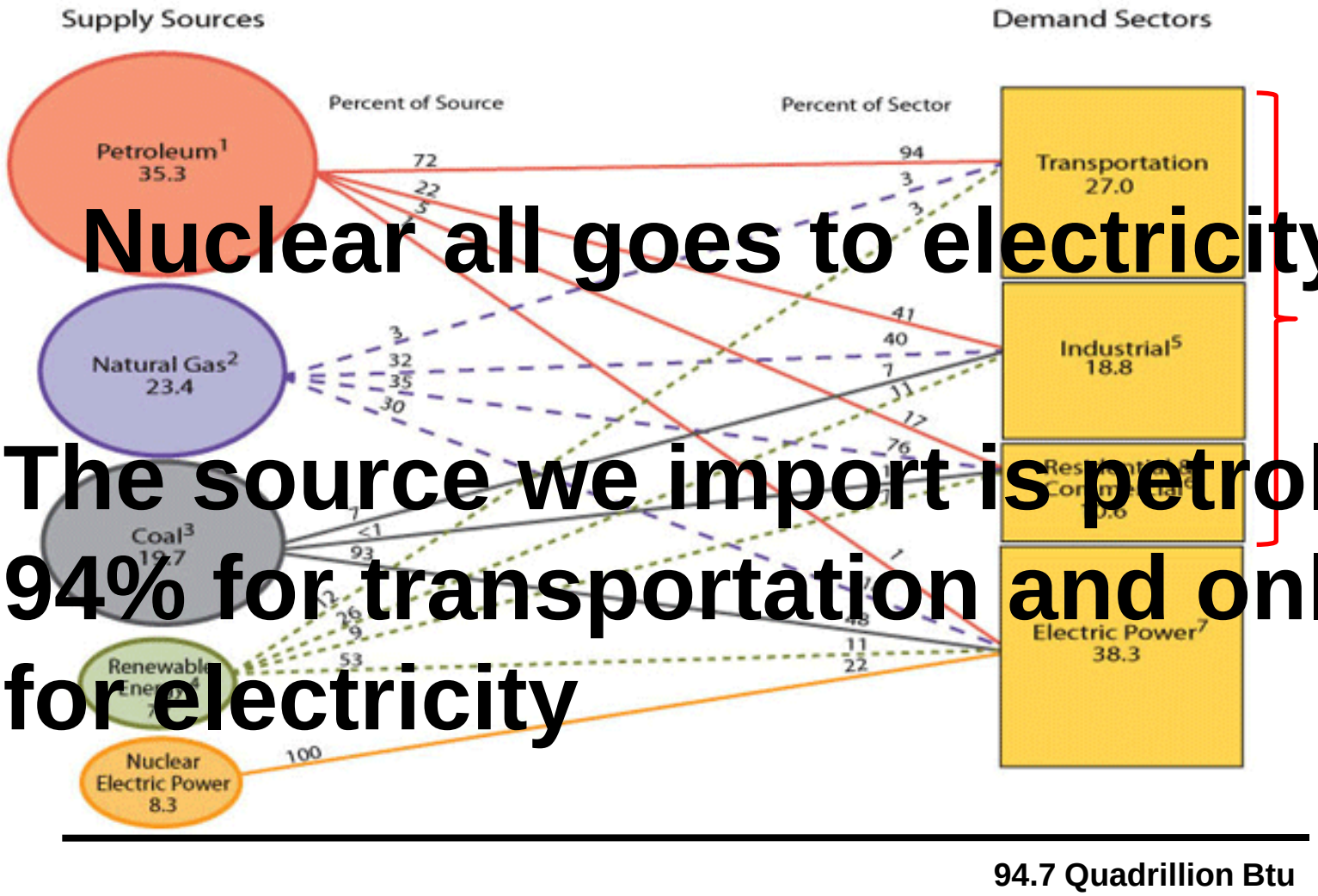
The Role of Renewable Energy in the Nation's Energy Supply, 2009



Note: Sum of components may not equal 100% due to independent rounding.
Source: U.S. Energy Information Administration, *Annual Energy Review 2009*, Table 1.3, Primary Energy Consumption by Energy Source, 1949-2009 (August 2010).

Biomass waste, Wood, and Biofuels are hydrocarbon fuels and makes up 50% of renewable energy, 4% of total energy

U.S. Primary Energy Consumption by Source and Sector, 2009 (Quadrillion Btu)



Nuclear all goes to electricity

The source we import is petroleum: 94% for transportation and only 1% for electricity

Source: Energy Information Administration, Annual Energy Review 2009

What is the BIGGEST Problem?

Transportation (Mobility) Fuels

Mobility is freedom

- Gasoline
- Diesel
- Jet Fuel



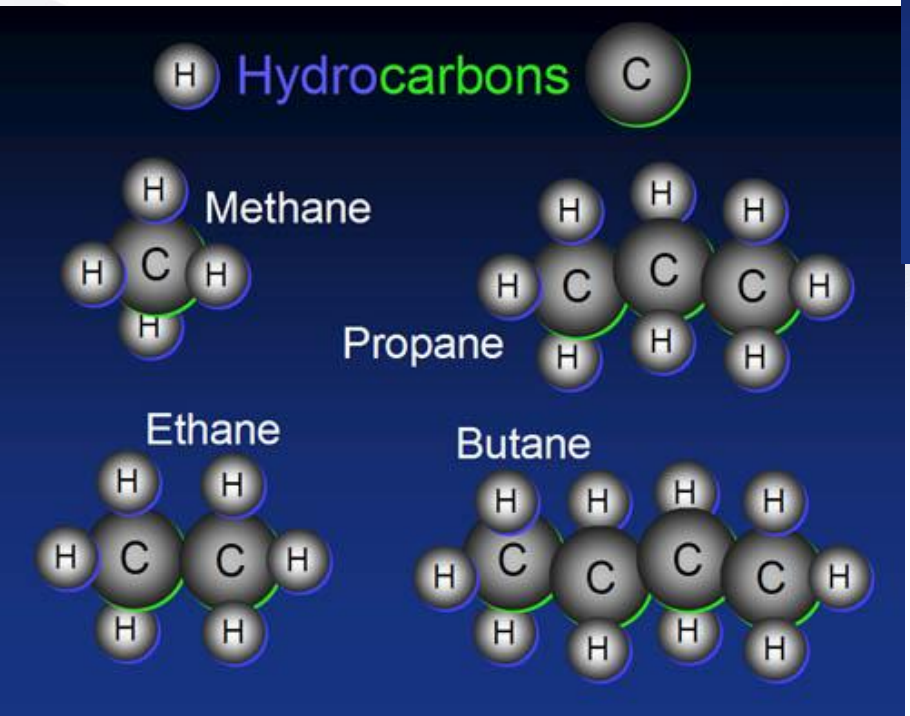

Electrification of transportation systems will help but not solve the problem

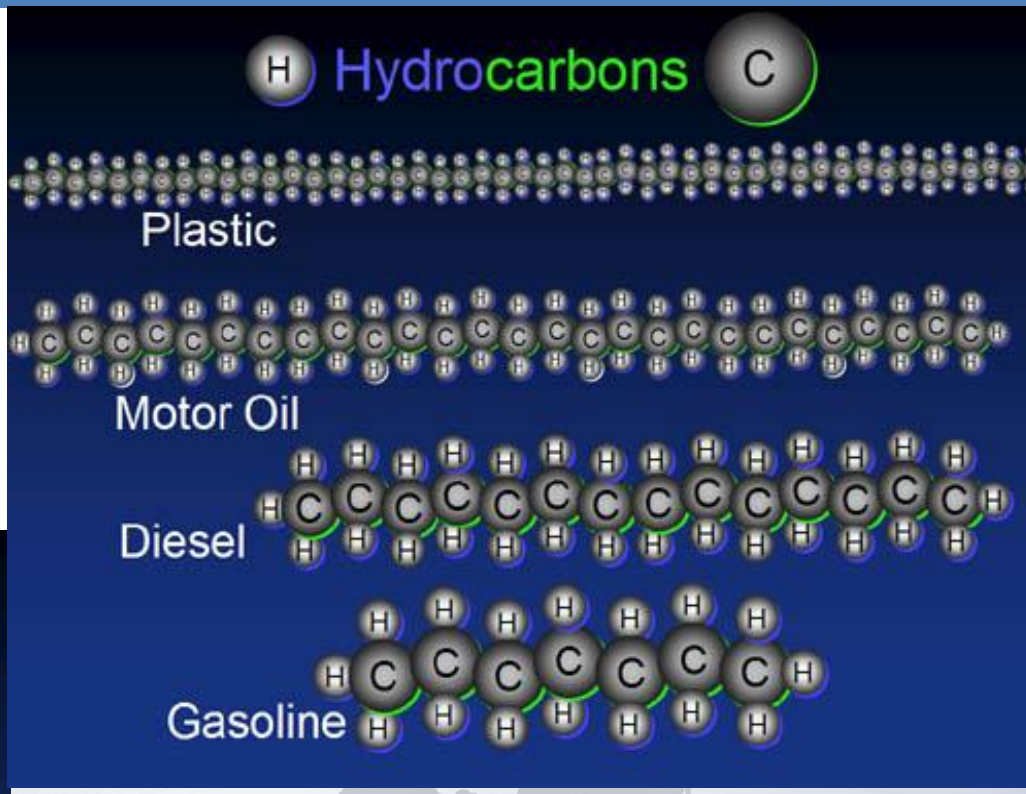
What about carbon?

- Carbon is essential to organic matter and life
  - Chemical basis of all known life
- Graphite and diamonds are allotropes of carbon
- Carbon forms more compounds than any other element
  - Known to form almost ten million different compounds
- Carbon is the 15th most abundant element in the Earth's crust
- Nature recycles carbon

Hydrocarbons

An organic compound consisting entirely of hydrogen and carbon

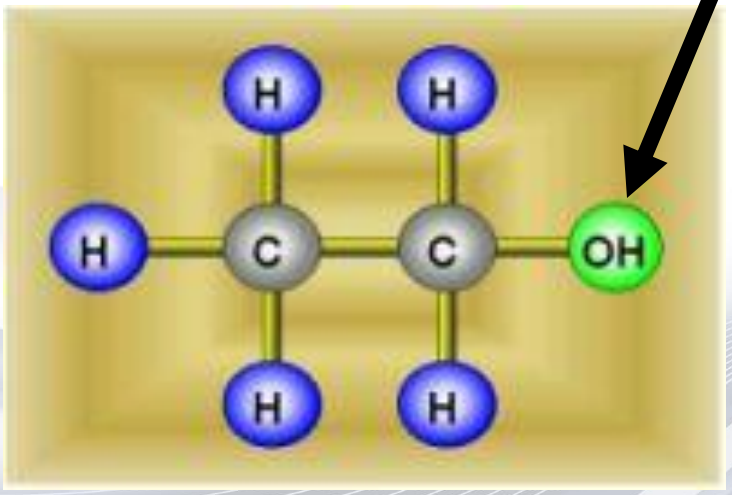




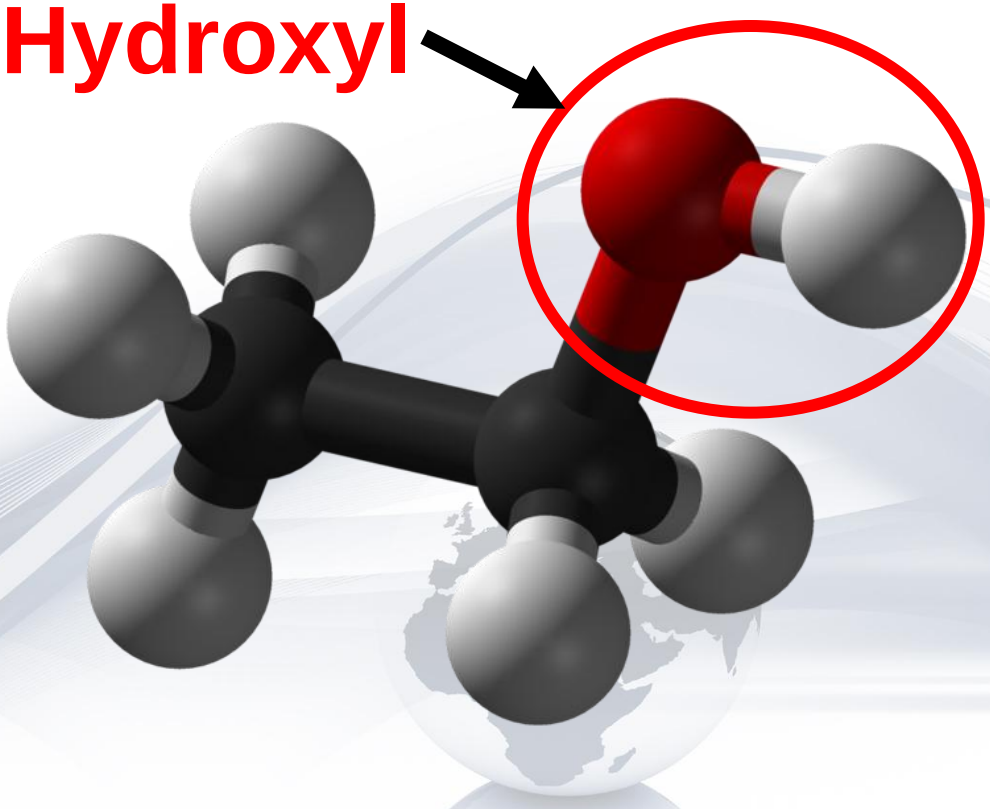
Practically an endless combinations (bonds) of hydrogen and carbon

Alcohols

An organic compound, simple alcohols formula are $C_nH_{2n+1}OH$



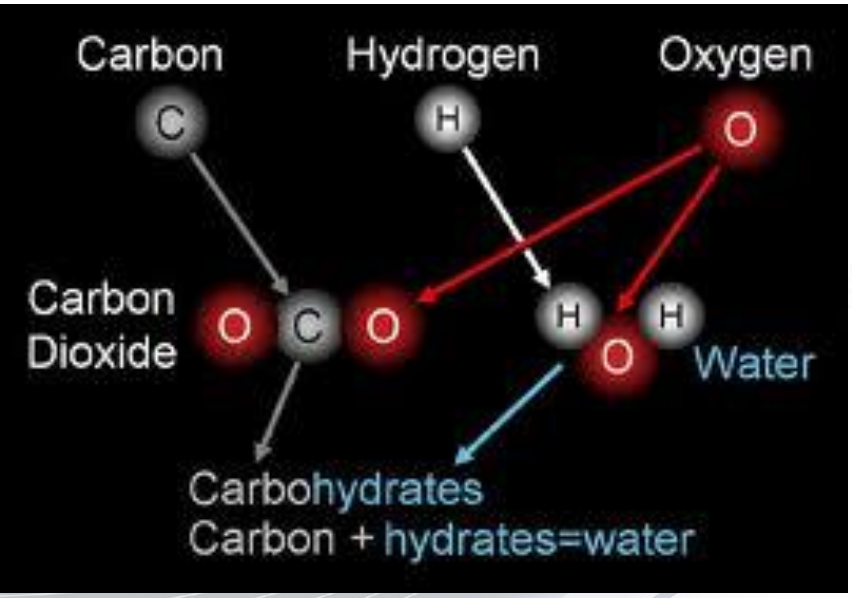
Hydroxyl

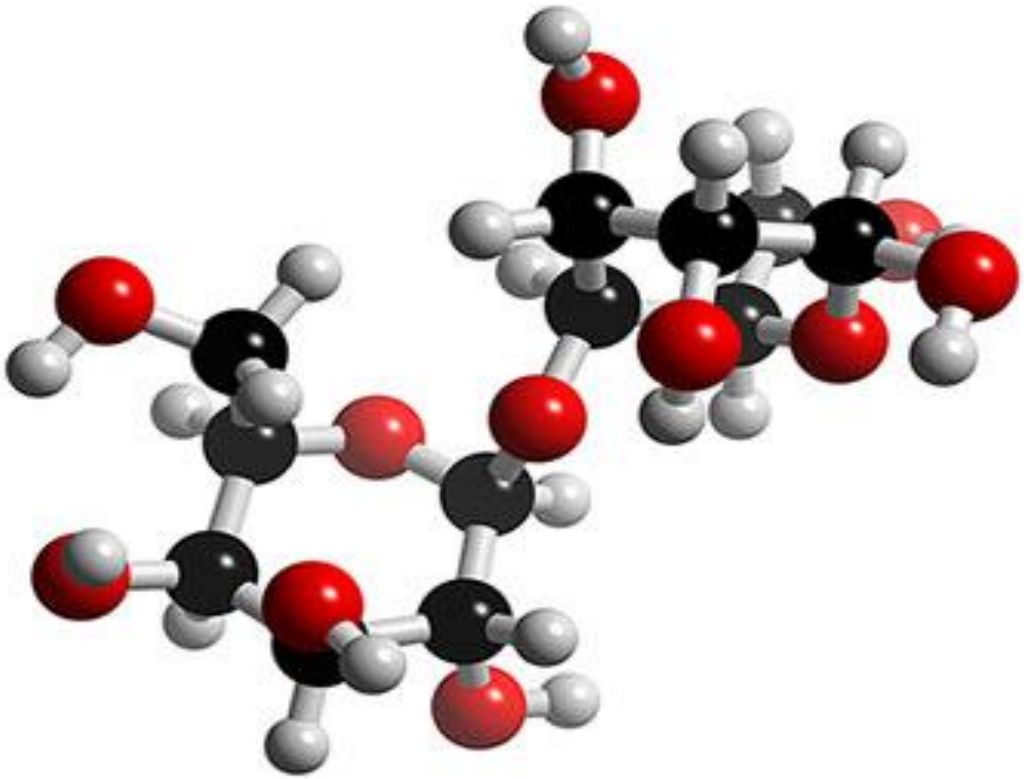


Ethanol (C_2H_5OH)

Carbohydrates

An organic compound with formula $C_m(H_2O)_n$

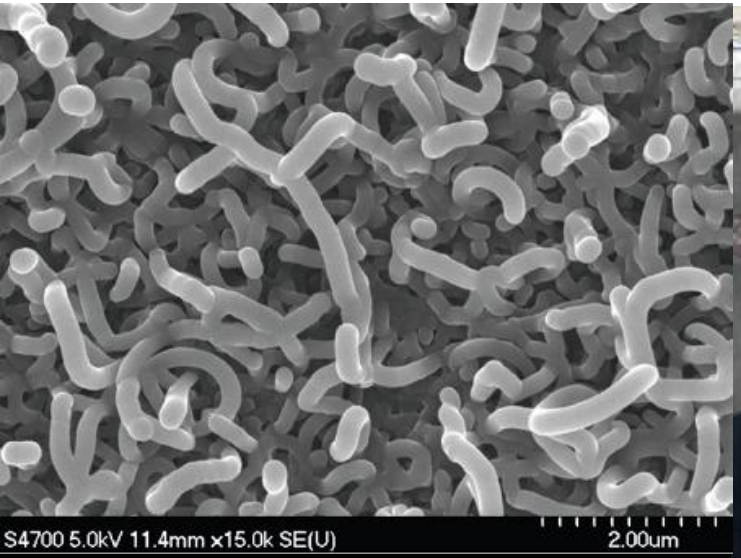




Lactose

Carbon reuse: e.g. Carbon Fibers

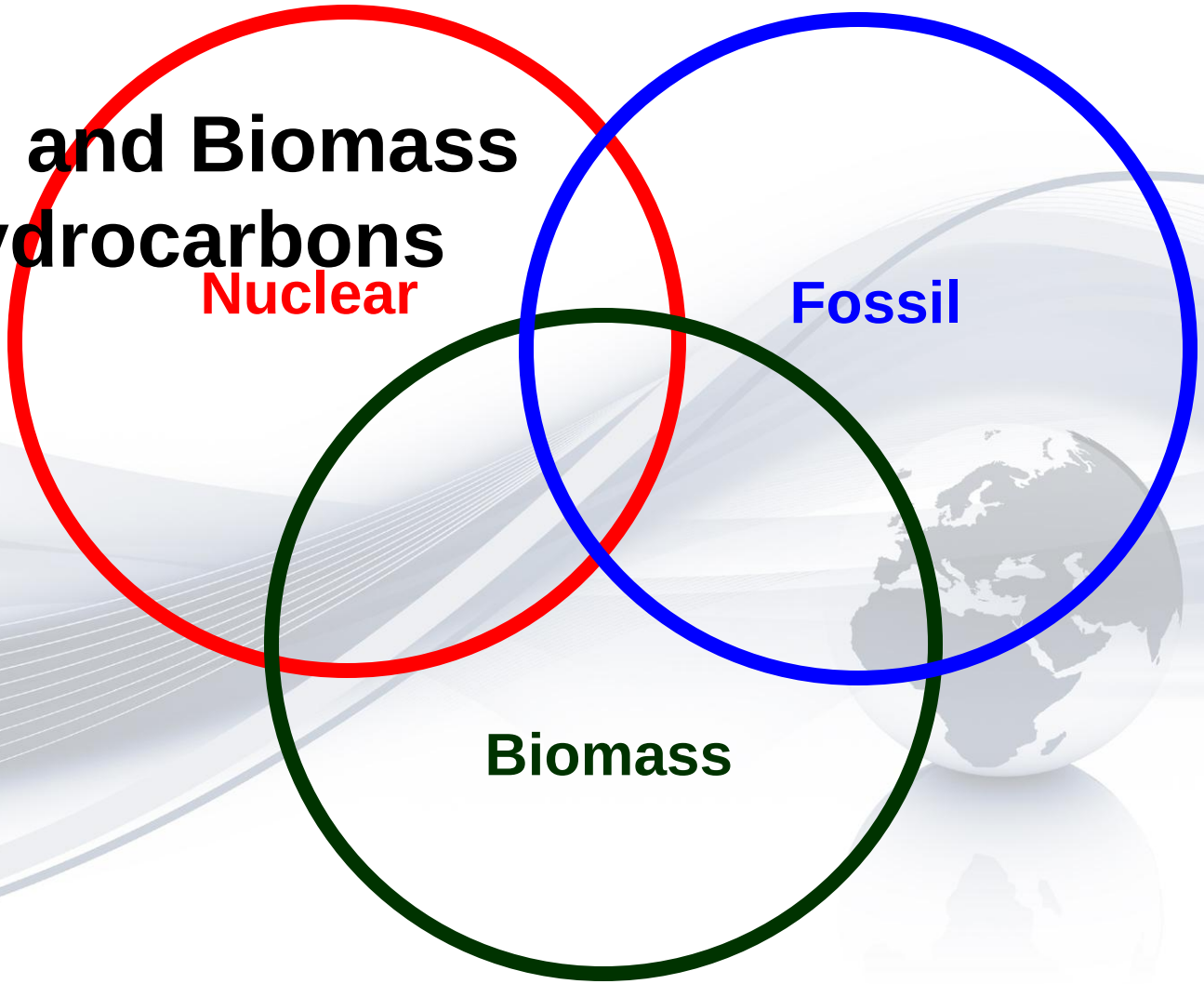
Can be used to make a multitude of products, including lighter more fuel efficient vehicles



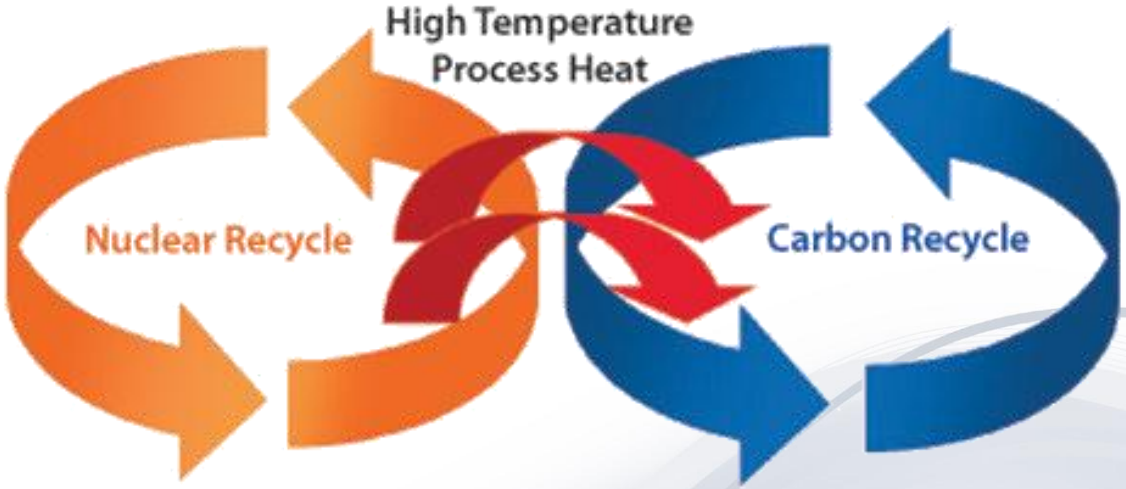
Combined Energy Systems

Dr. Charles Forsberg, MIT and former Corporate Fellow at ORNL

Fossil and Biomass are hydrocarbons



A Potential Technological Approach

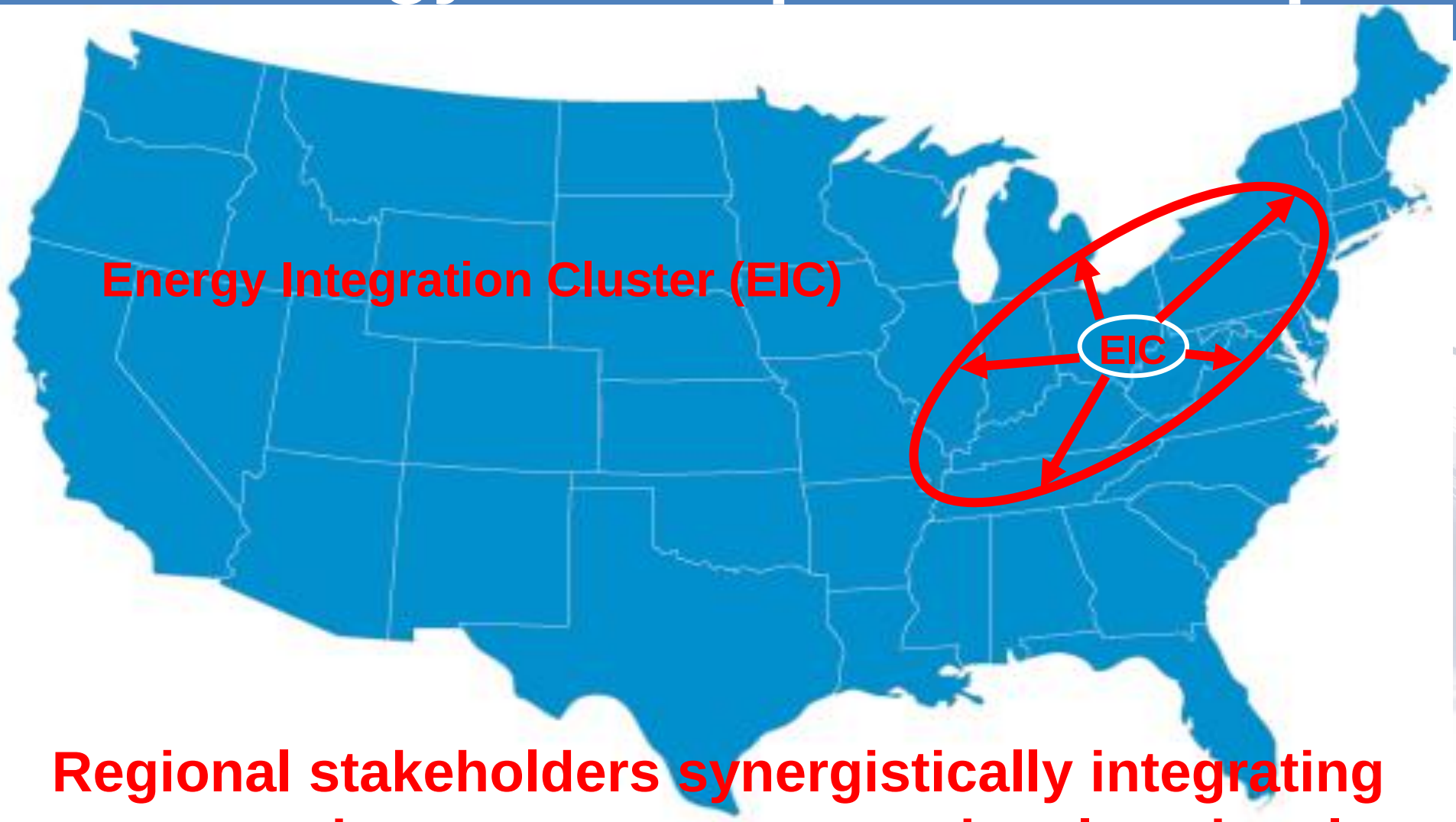


- **A hybrid (combined) clean energy system**
  - Begin closing the nuclear and carbon fuel cycles with high temperature process heat and hydrogen from a carbon free source, H_2O
- Produce electricity, hydrogen, hydrocarbons, and specialty chemicals
- Carbon Capture and Recycle (CCR)

Key Enabling Technologies

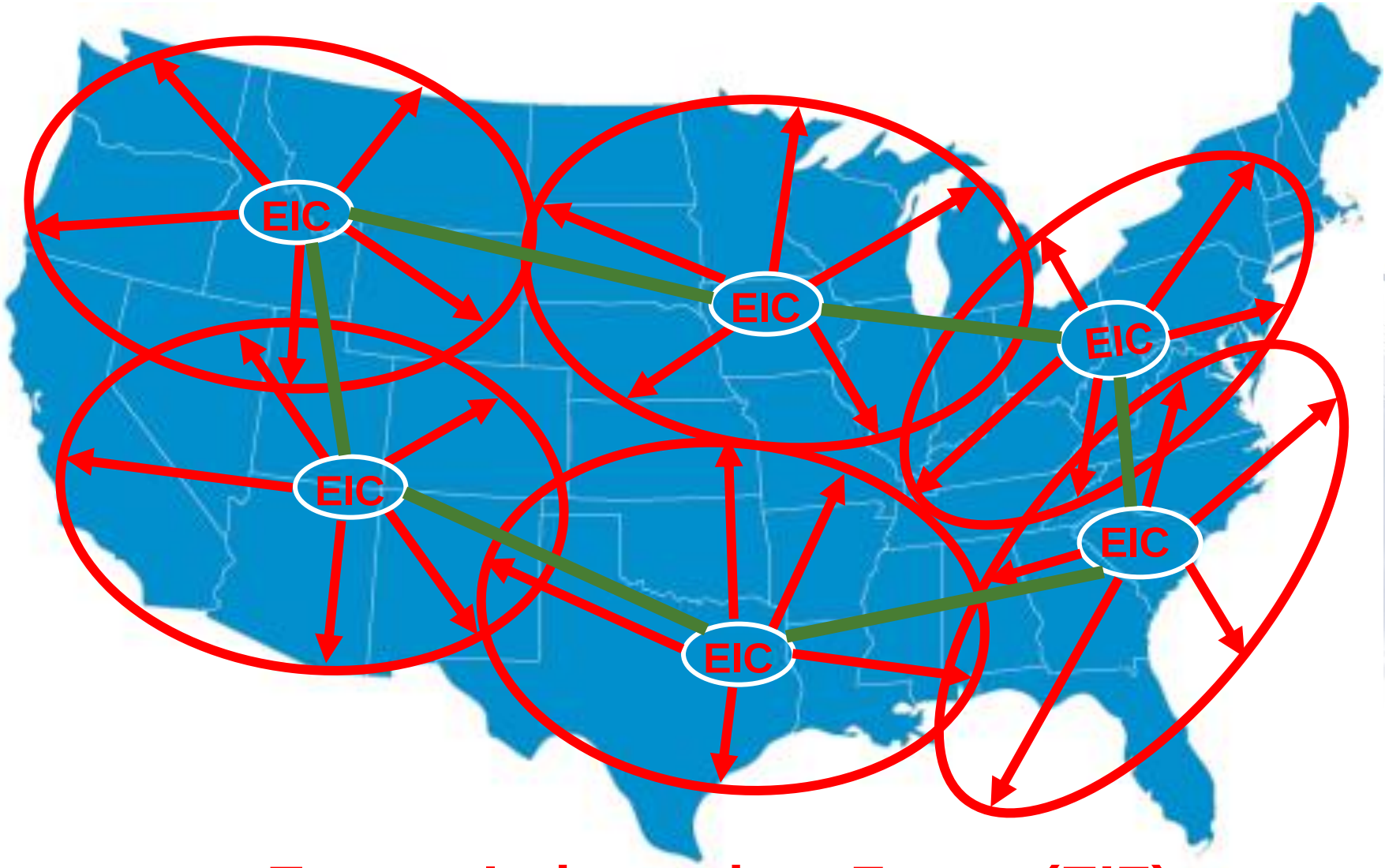
- **Energy conversion**
  - **Nuclear (fission or fusion)**
    - **High temperature reactors**
  - **Hydrogen (H_2O splitting and purification)**
  - **Hydrocarbon: chemical processing, CO_2 capture and recycle, etc**
- **Materials**
  - **High temperature**
  - **Carbon based materials**
- **Recycling** (Lifecycle Designing)
  - **Separations**
  - **Capture/collection**
  - **Transport and storage**

An Energy Development Concept



Regional stakeholders synergistically integrating assets and resources to meet regional, national and global energy needs.

Energy Integration Clusters



Energy Independent Zones (EIZ)

How Can We Obtain Energy Security?

- **Break dependence on fossil fuels** by synergistically applying existing technologies and aggressive innovative purpose-driven RDD&D
  - **Production must be "KING"**
- **Have a roadmap utilizing a comprehensive systematic and integrated approach**
- Work **together for energy independence**
  - Reach-out and make relationships with other professions
    - Scientists, engineers, politicians, journalist, lawyers, environmentalist, etc.
  - Seek and value other's opinion
  - Educate and be teachable
- **Bold deliberate action** with a sense of urgency

Another Quote

"The wise man questions the wisdom of others because he questions his own, the foolish man, because it is different from his own."

- Leo Stein

Last Quote

"You cannot escape the responsibility of tomorrow by evading it today."

Abraham Lincoln

Vision, Determination, Leadership