Overview of Biomass Thermal Energy & CHP

California State Wood Energy Team Meeting

June 17, 2014

Adam Sherman

BERC Biomass Energy Resource Center

Biomass Energy Resource Center (BERC)

Advancing Community-scale Biomass Energy in North America

Technical Consulting

- Project feasibility studies
- Fuel supply assessments and procurement
- Third-party expert review
- Develop and review of standards
- Market Assessments

Program Design & Implementation

- Expansion potential assessments
- Program management
- Training, and advisory support services

Advocacy

- Showcasing “best practices” and case studies of successful projects
- Tracking market growth and impacts

BERC is a program of the Vermont Energy Investment Corporation
A mission-driven non-for-profit whose mission is to reduce the economic and environmental impacts of energy production and consumption

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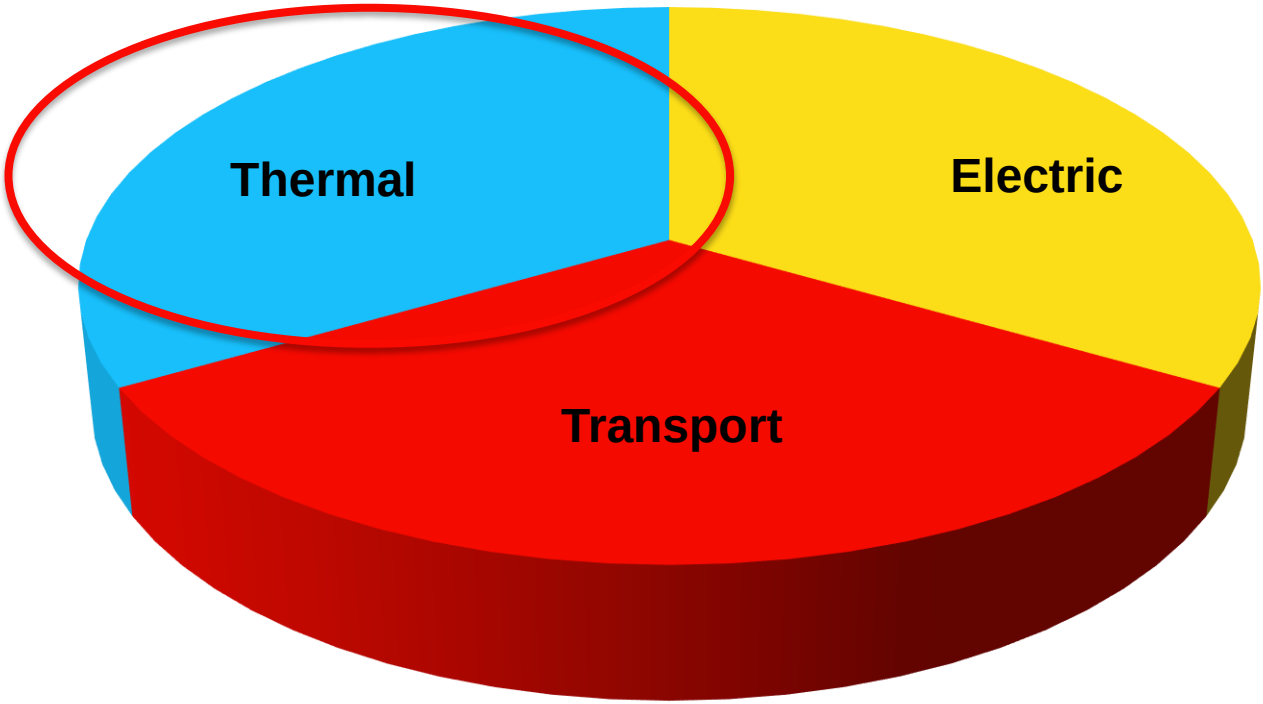
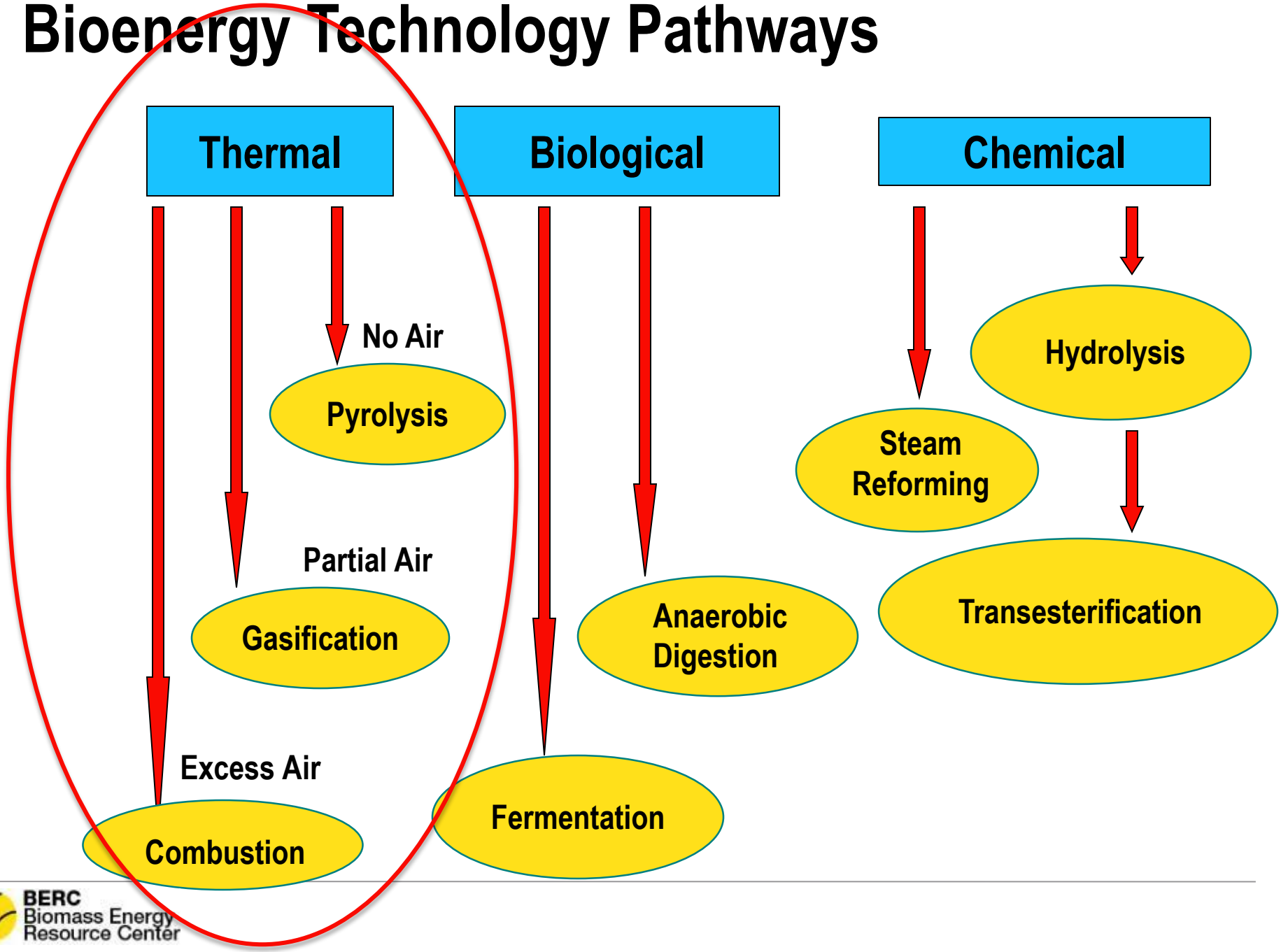
US Energy Consumption by Energy Sector



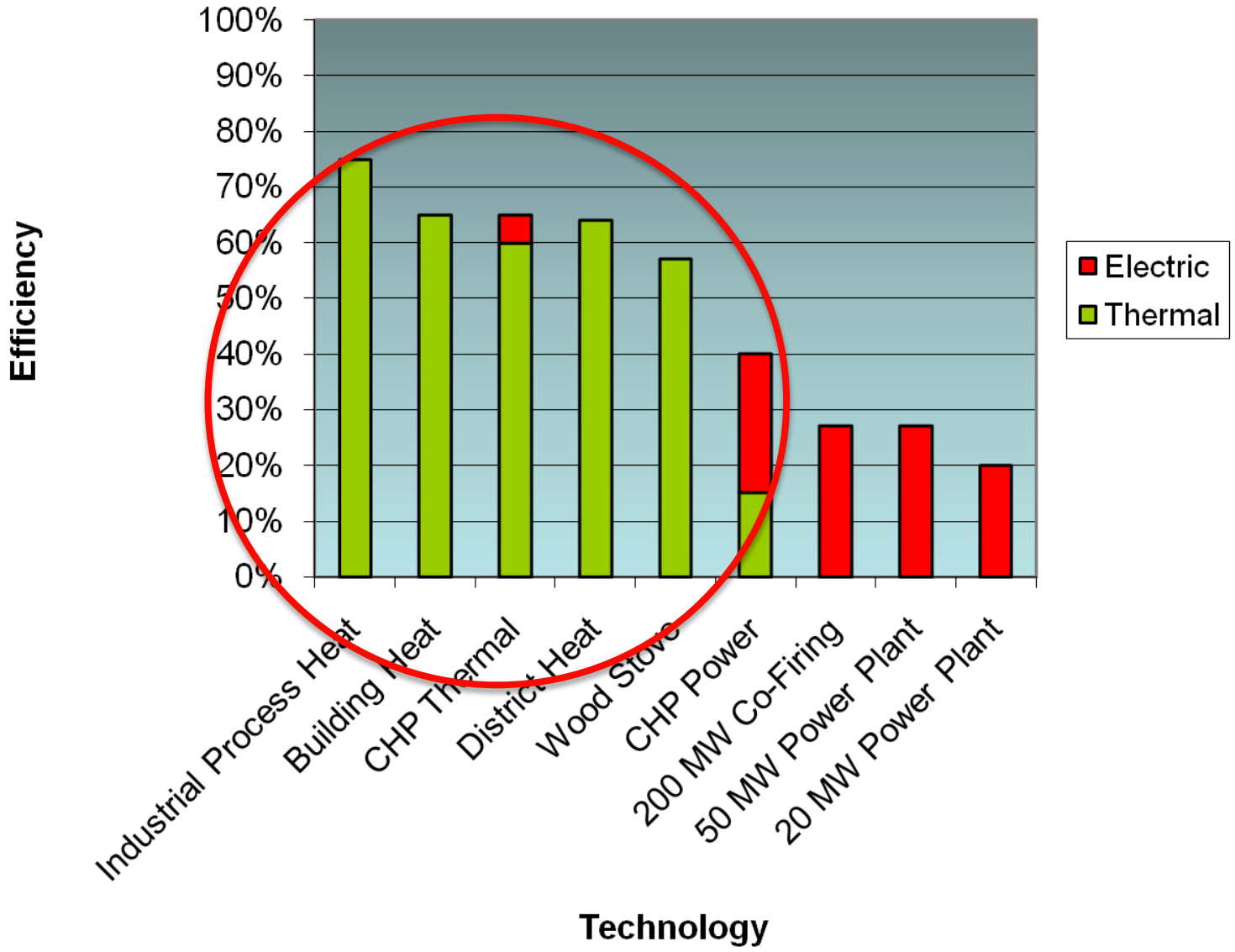
Renewable Energy Matrix

	Heat	Electricity	Fuel Gas	Fuel Liquids
Solar	✓	✓		
Wind		✓		
Geothermal	✓	✓		
Hydro		✓		
Biomass	✓	✓	✓	✓

Bioenergy Technology Pathways



Efficiency of "Off the Shelf" Conversion Technologies



Traditional Wood Heating Fuels

Chunkwood

PROS: Simple, cost effective, easy to self-supply

CONS: Manual feed, less efficient combustion, less convenient

Woodchips

PROS: Cost effective fuel, by-product supply, great for heating large facilities

CONS: High capital costs, not effective for residential heating

Wood Pellets

PROS: Energy dense fuel, clean burning, efficient, and convenient

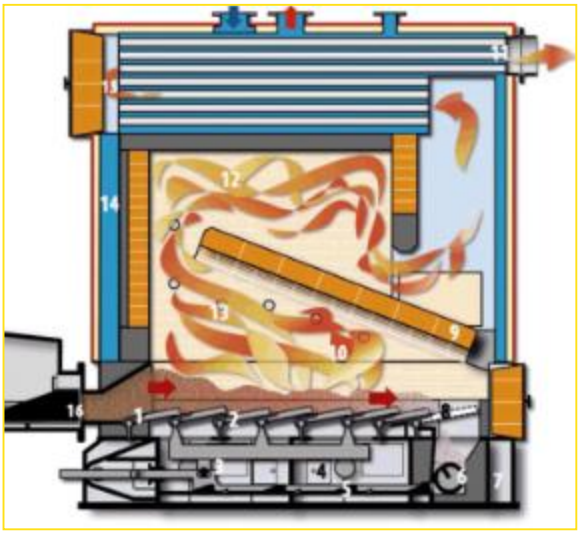
CONS: Slightly higher cost per MMBtu

Perceptions of "Biomass Heating"

Modern Wood Boiler Technology

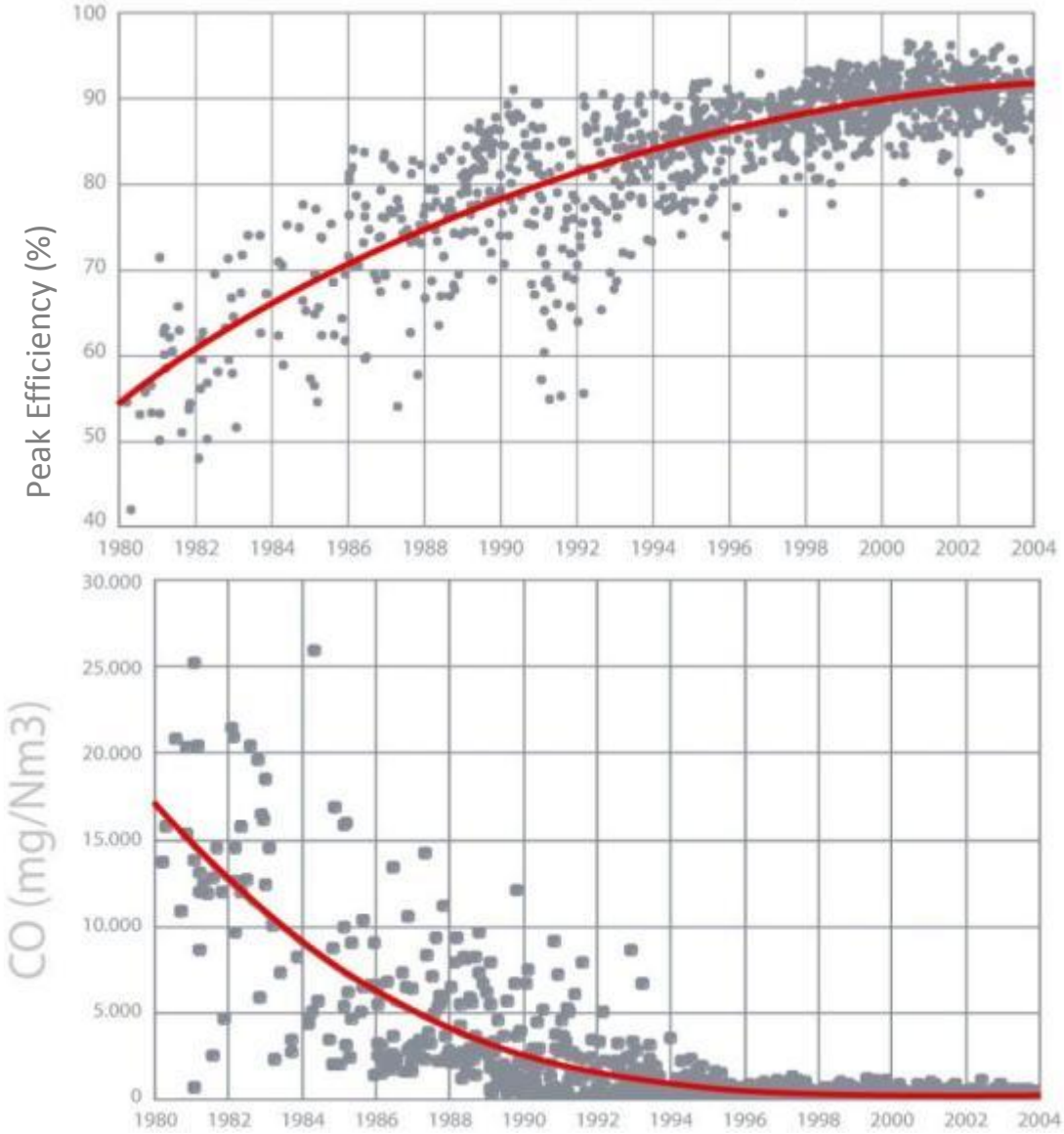
Cordwood system

Pellet system



Woodchip system

Advancements in Modern Combustion



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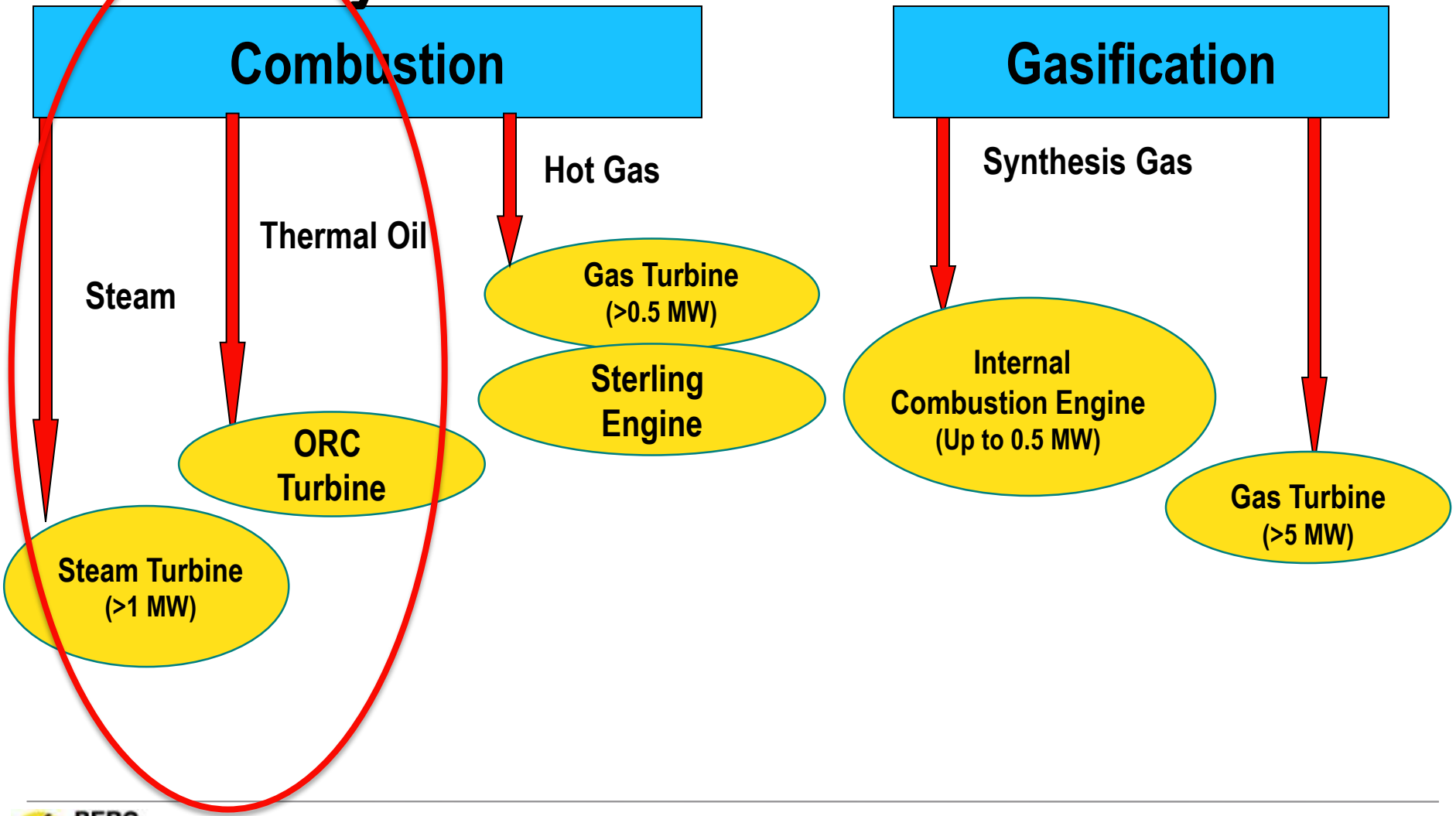
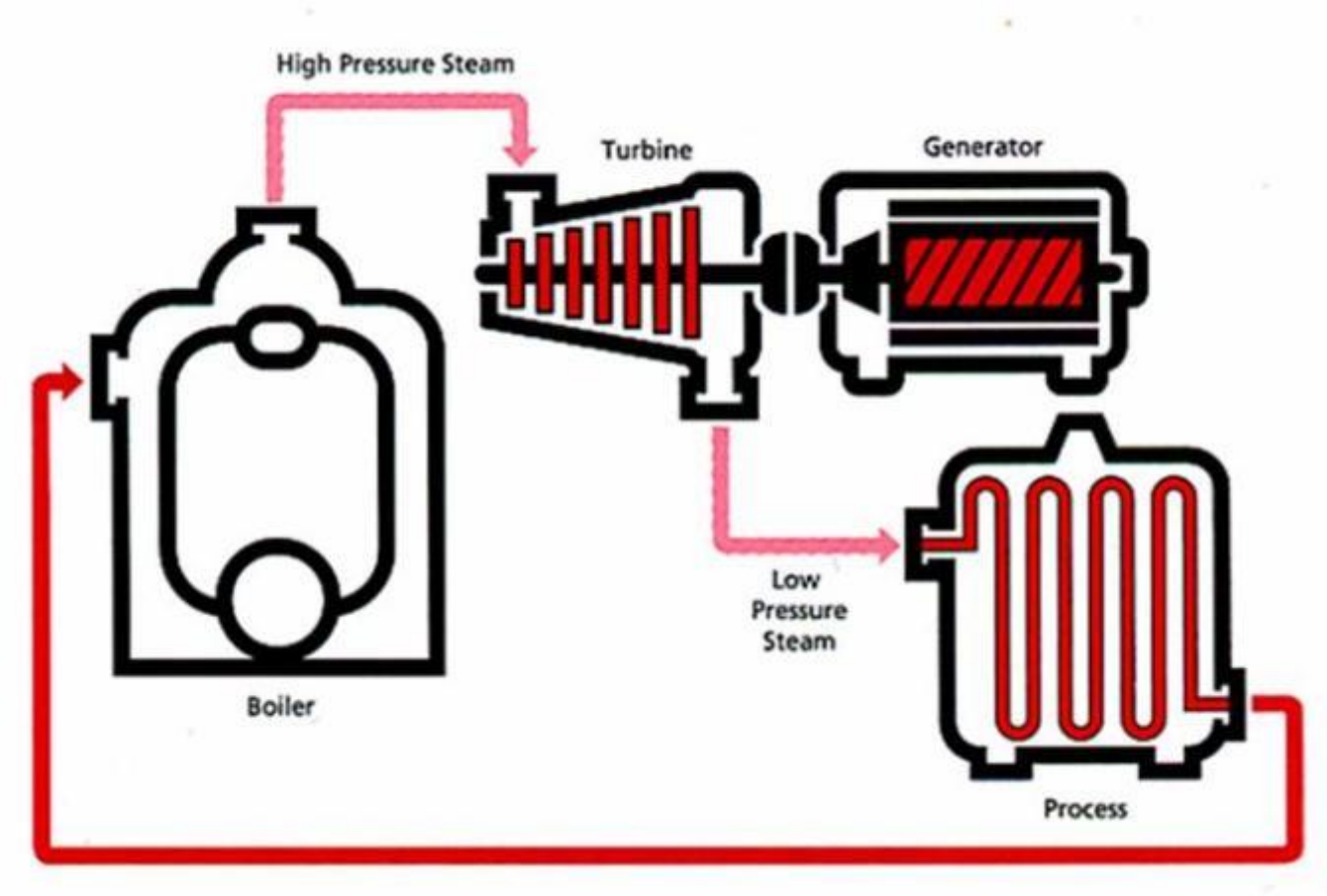
Source: Dr. Christian Rakos, ProPellet, Austria

Technology	Cordwood Boilers	Pellet Boilers	Single Facility Woodchip Heating	District Heating w/Woodchip Boilers	Industrial CHP
					
Typical heat output capacity	20kW – 100kW	20kW - 1MW	500kW – 9MW	1.5MW – 15MW	8MW - 150MW
Applications	Home heating and farm buildings	Home heating & small commercial buildings	Schools, hospitals, office buildings, etc.	College campuses and downtown communities	Merchant Power Plants
Fuel Type					
Annual Fuel Use	2-15 cords	2-20 tons	100 – 10,000 tons	500- 50,000 tons	1,000 – 500,000 tons
Fuel Sourcing	Locally harvested firewood	Premium pellets	Paper grade and screened bole chips	Bole chips and whole-tree chips	Whole-tree chips and hog fuel
Average Efficiency	65%	80%	75%	75%	28% - 40%

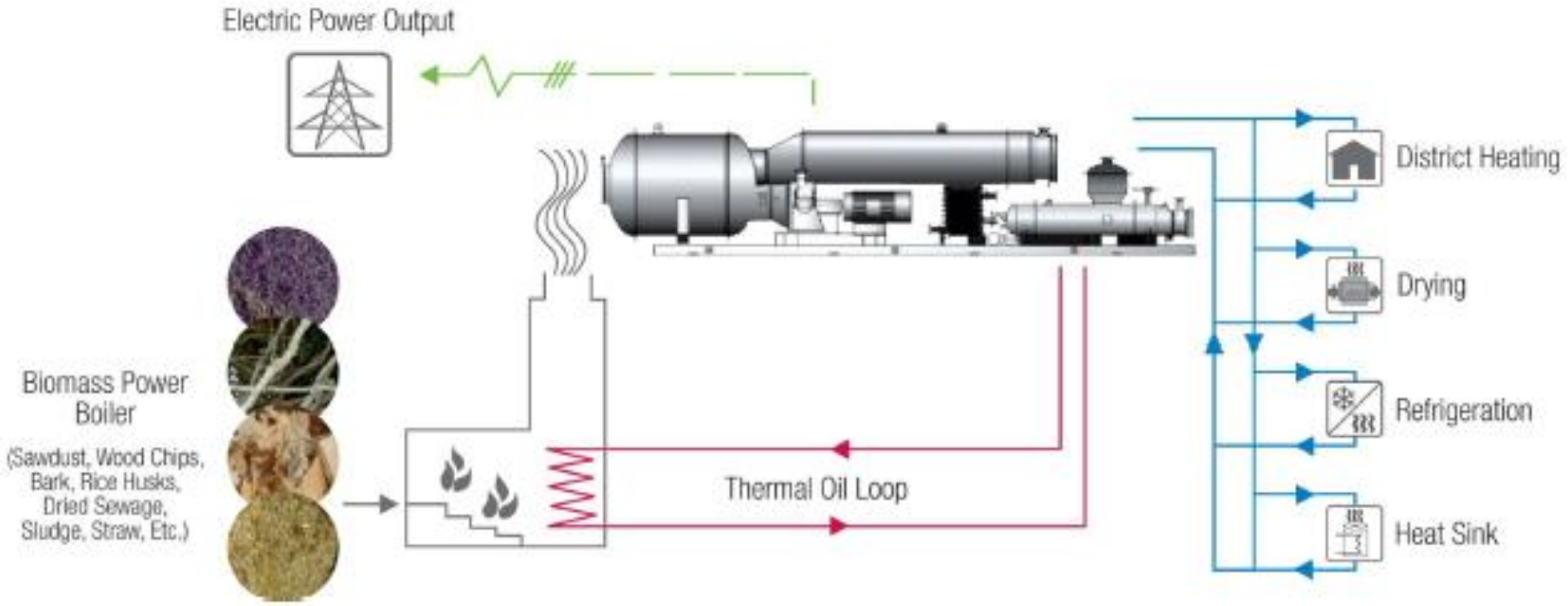
Biomass CHP Technology Pathways



Steam Turbine CHP Technology

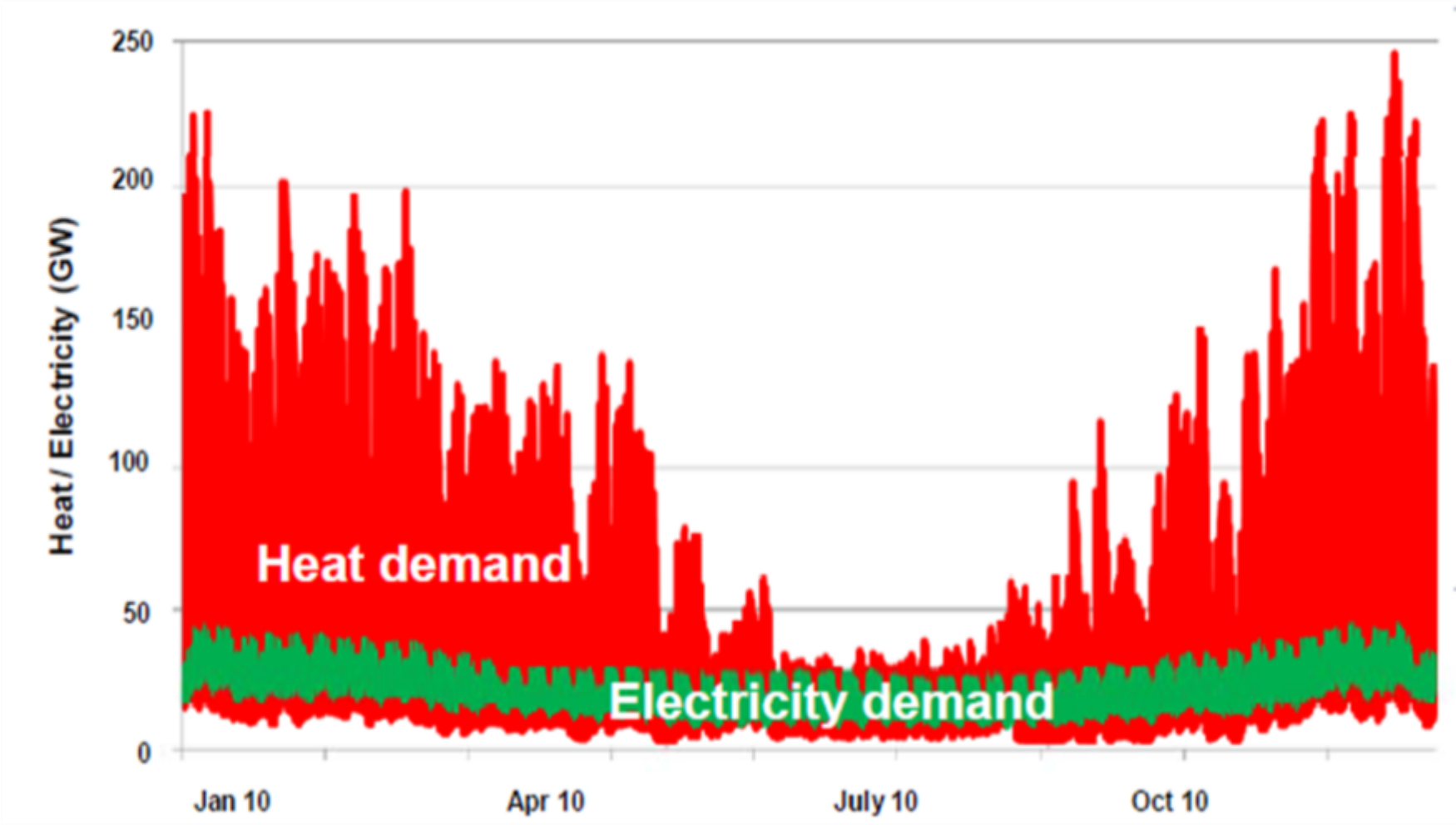


Organic Rankine Cycle (ORC) CHP Technology

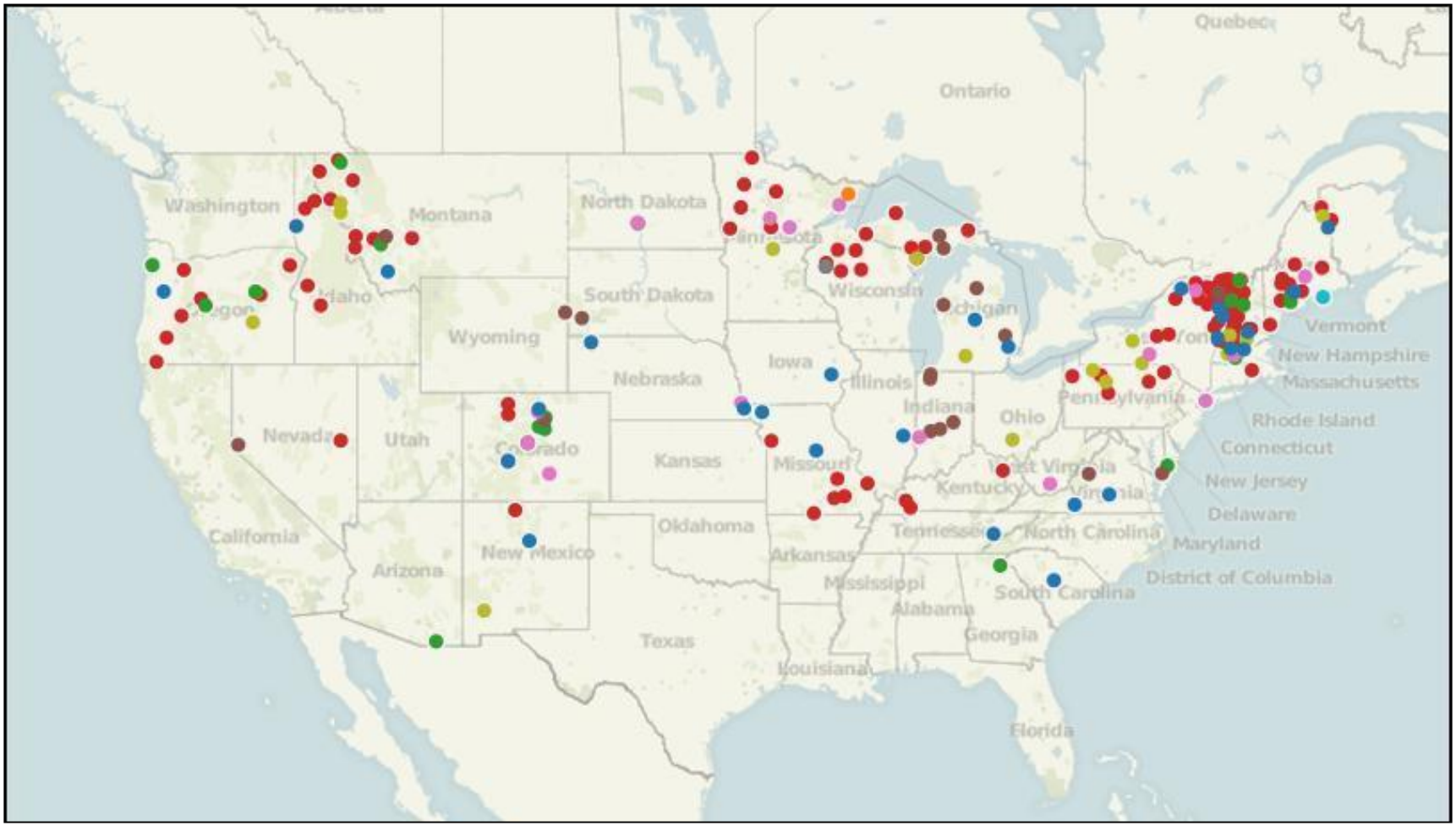


Gasification to IC Engine CHP Technology

Matching Loads for CHP



Community-scale Modern Wood Heating Projects in the US



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CAMPUS WOODCHIP HEATING SYSTEM

Middlebury College

MIDDLEBURY, VERMONT, UNITED STATES

- **Heating Capacity (output):** 8.8 MW (30 MMBtu/hr) Electric output 0.5 MW
- **Year Installed:** 2008
- **Fuel Use**: 20,000 GT/yr
- **Thermal Output:** Steam for heating, cooling, and power generation

WOODCHIP DISTRICT CHP SYSTEM

Towns of Toblach and Olang

SOUTH TYROL, ITALY

- **Heating Capacity (output):** One 10 MW (34 MMBtu/hr) boiler and two 4 MW (14 MMBtu/hr) boilers
- **Electrical Capacity:** 1.5 MW
- **Emissions Reduction and Combustion Control Equipment:** Multi-cyclone, electrostatic precipitator, condensation plant, moving grates, O_2 sensor control
- **Year Installed:** 1995
- **Thermal Output:** Hot water
- **District Heating Network Length:** 44 km (27 miles)
- **District Heating Customers:** 900

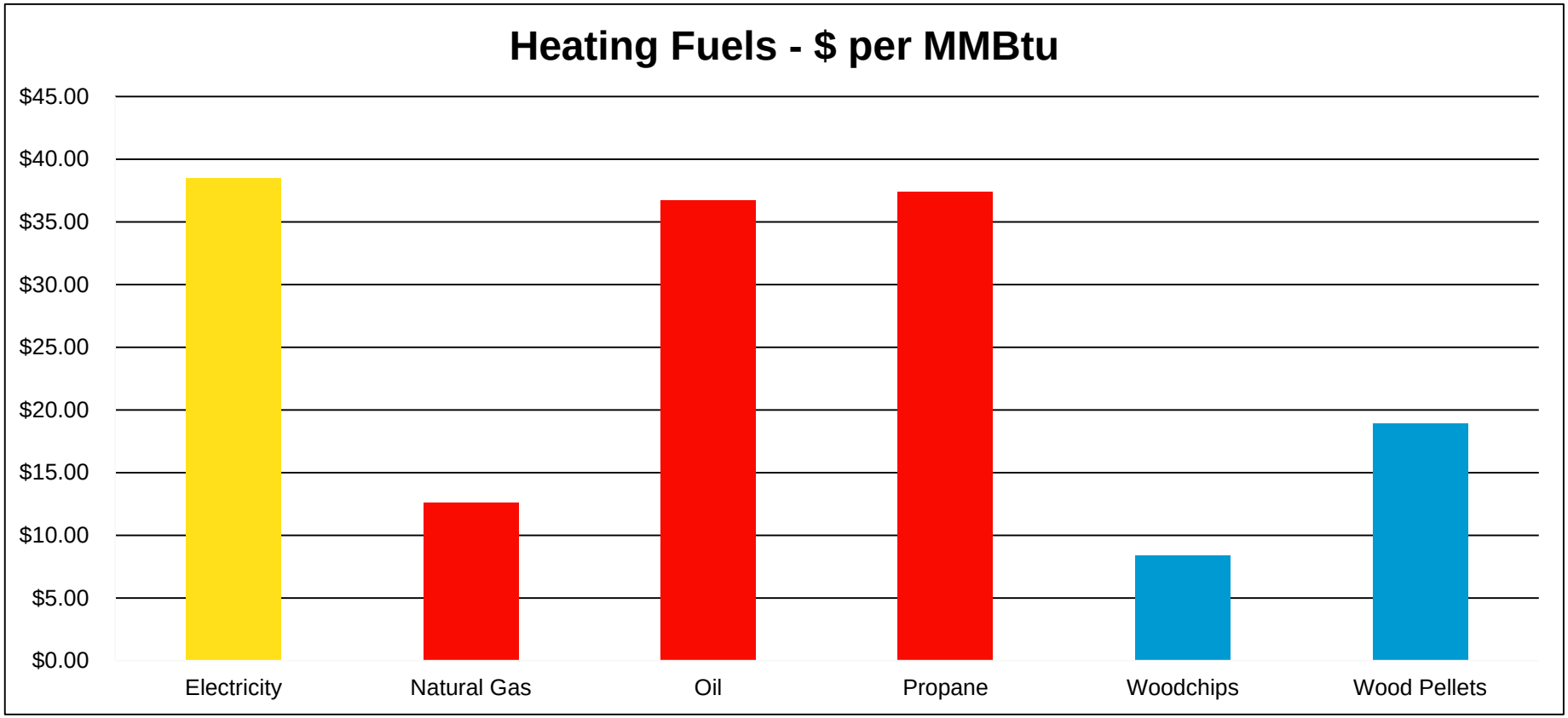
WOODCHIP DISTRICT CHP SYSTEM

Vølund Gasifier Plant and Town of Harboøre

JUTLAND, DENMARK

- **Heating Capacity (output):** 4 MW (14 MMBtu/hr)
- **Electrical Capacity:** 1.6 MW
- **Emissions Reduction and Combustion Control Equipment:** Electrostatic precipitator
- **Year Installed:** 2000
- **Thermal Output:** Hot water
- **District Heating Network Length:** 10 km (6 miles)
- **District Heating Customers:** 900

Cost of Heating Fuels in the US



Data sources: EIA and BERC

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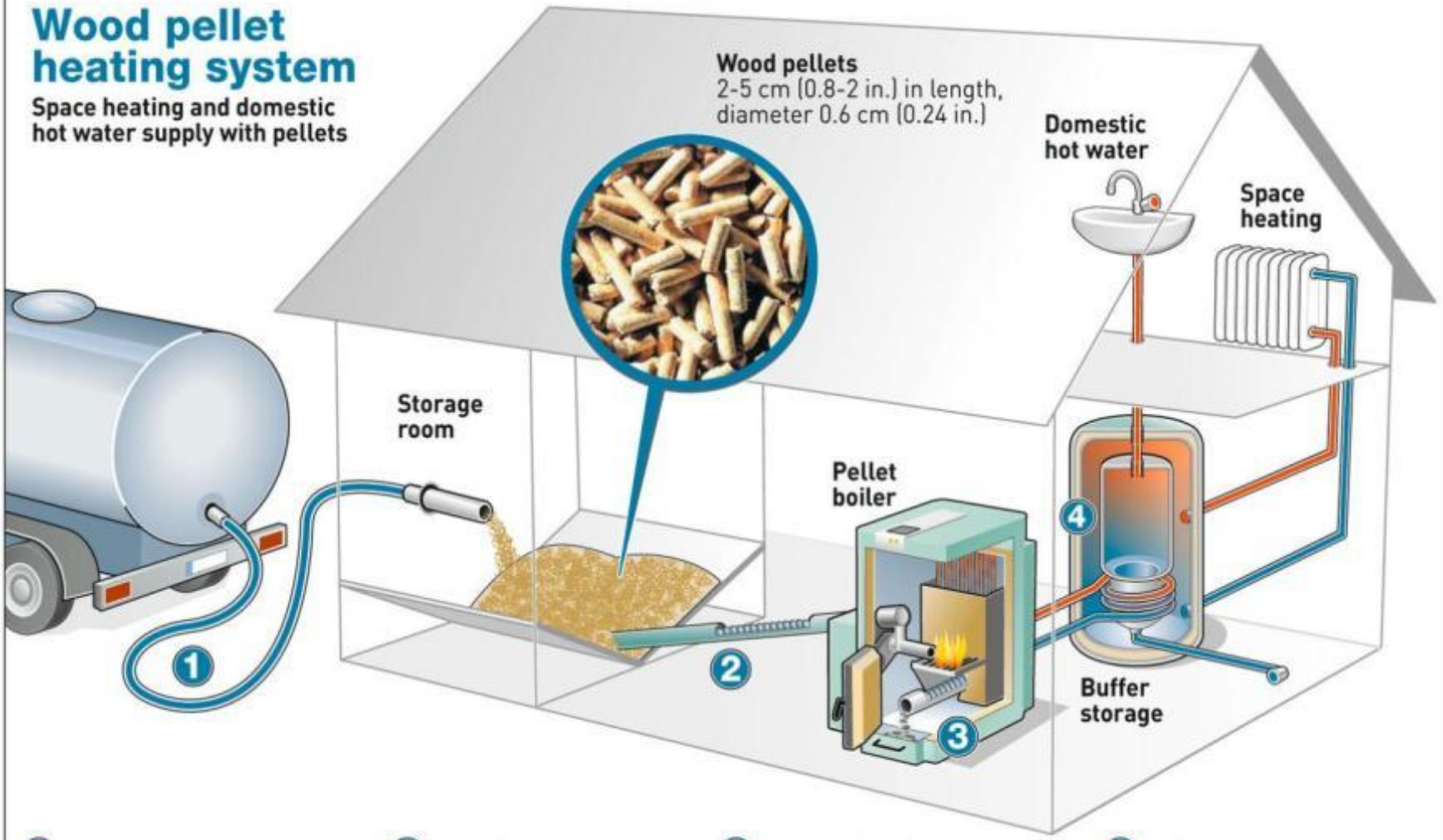
Wood pellet heating system

Space heating and domestic hot water supply with pellets

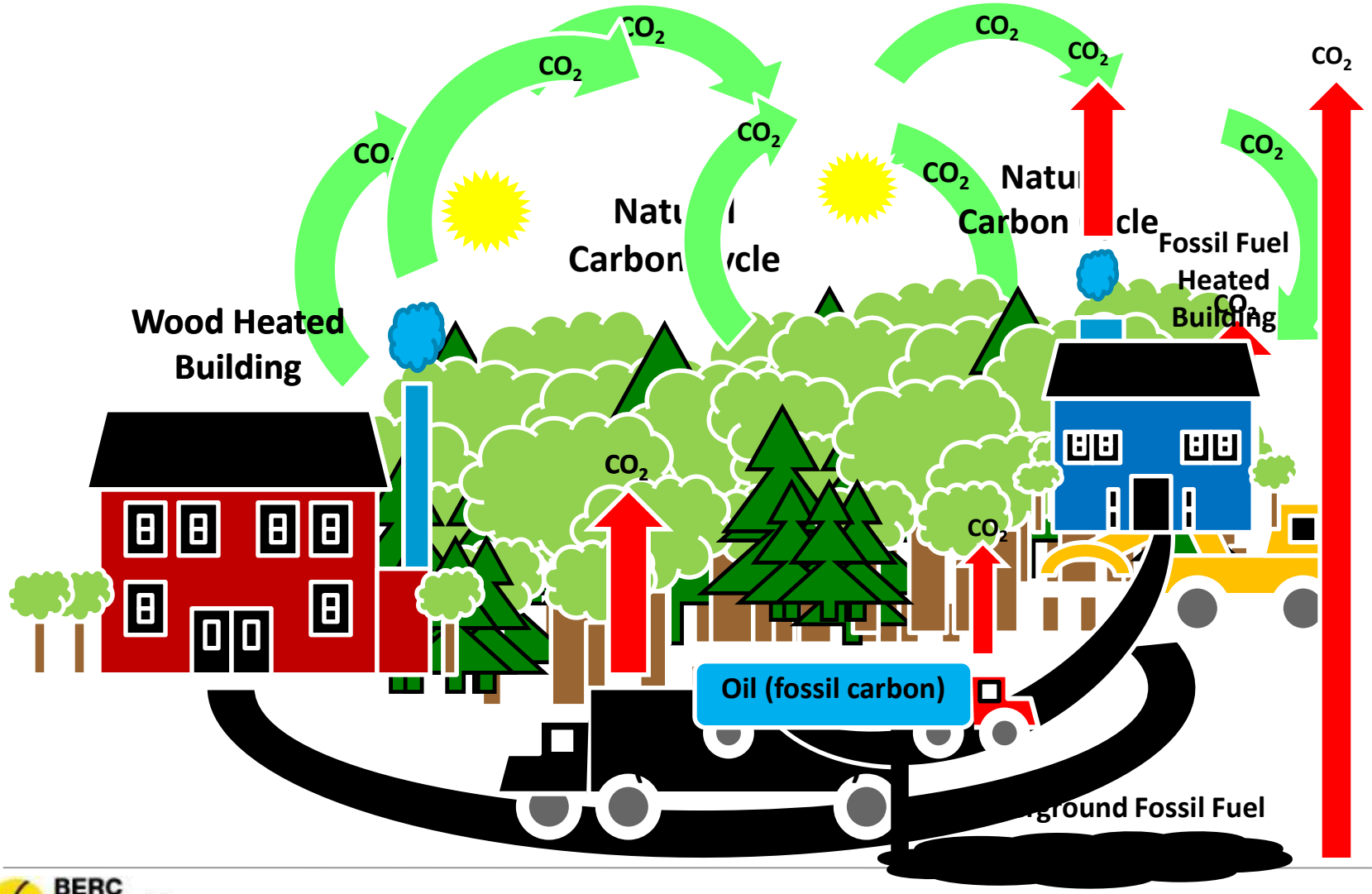


1. Once or twice a year the pellets are delivered by a silo tanker. A loaded storage room of 4.5 m² is enough to keep a single-family house warm for one year.
2. The pellets are carried from the storage room to the boiler by a fully automatic pellet feed.
3. After the burning process all that's left is ash – with a weight of only 0.5 per cent of the original pellet. The ash can be disposed of with the domestic waste.
4. If the pellet boiler is interconnected with a buffer storage, emissions can be reduced and efficiency increased.

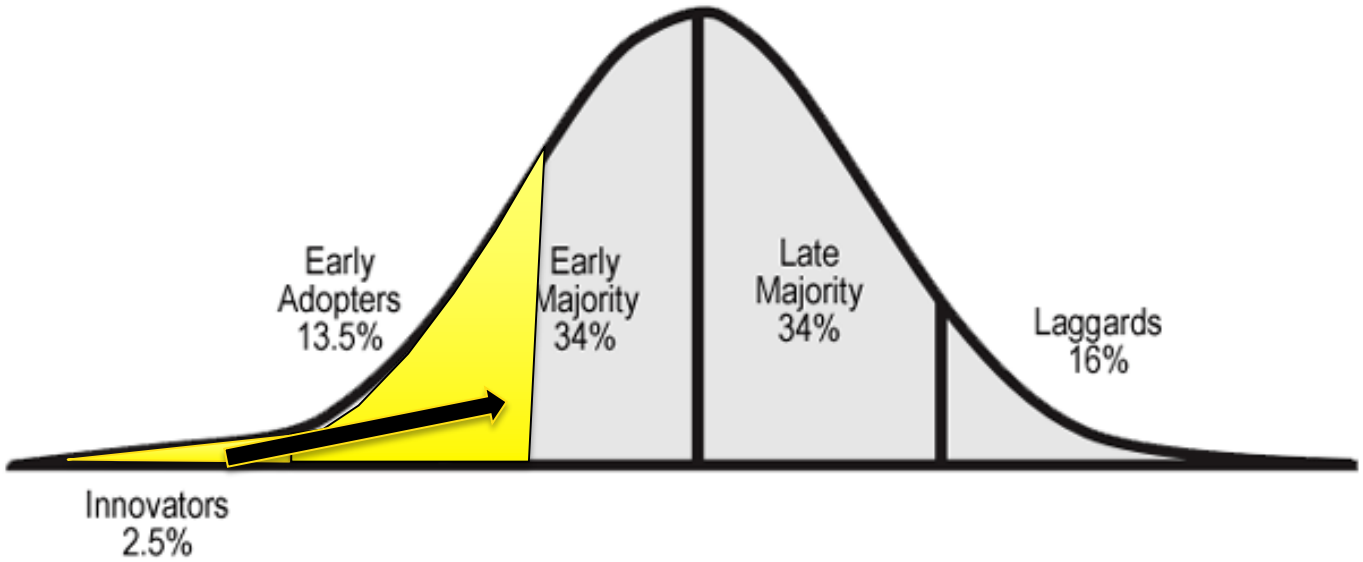
www.unendlich-viel-energie.de

The Carbon Cycle

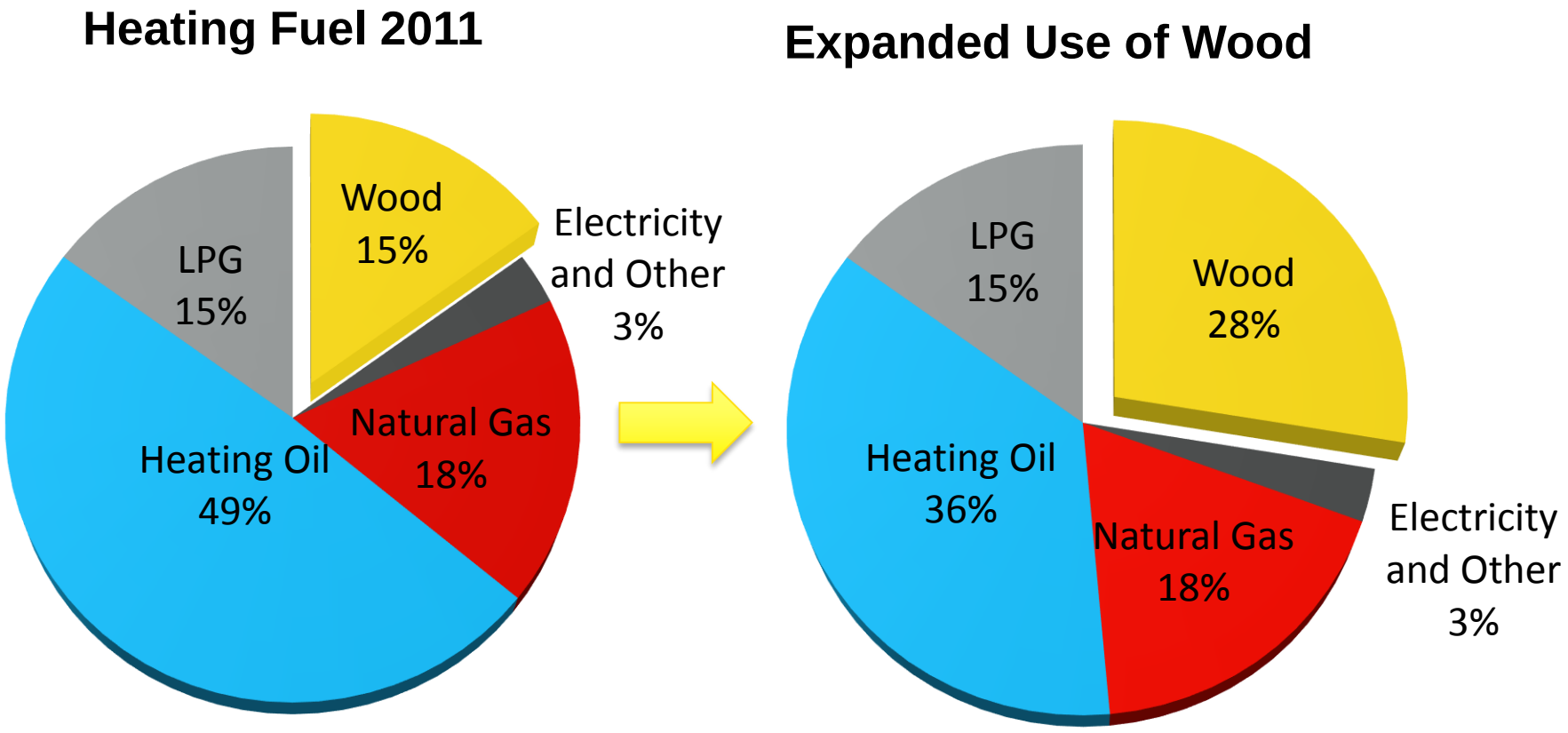
Biomass Heated Buildings vs. Fossil Fuel Heated Buildings



Approach to Sector Focused Market Transformation



Opportunity for Expanded Biomass Heating in VT



Source: VPIRG Clean Heat Report & EIA consumption data

Spectrum of Policies and Incentives Offered in VT

	NY	VT	NH	ME	MA
Flexible Boiler Regulations		√	√		
Sales Tax Exemption on Biomass Appliances			√	Partial	Partial
Sales Tax Exemption on Biomass Fuel		√	√	Residential only	Residential only
State Income Tax Credit			N/A		
Pellet Boiler Incentives		√	√		√
PACE Financing		√			
Thermal RPS			√		Almost
State Grants for Biomass Thermal Projects	√	√	√	√	√
Government “Lead by Example” for Biomass Thermal		√			√
System Benefits Charge		**Weatherization only**			
Mandatory Renewable Energy Targets Applied to Building Codes					

Source: http://www.veic.org/Media/berc/Summary-BT-Policy-Report10.30.13.pdf

Policy Options for Overcoming Market Barriers for Biomass Therma

Barrier	Potential Policy Solution
High capital costs	• Federal 30% tax credit • State income tax credits • State funded rebate programs • Thermal inclusion in RPS in a way that creates “credit worthy” thermal RECs used toward capital costs
Public awareness	• Adopt policies such as “lead by example” programs by state and local government • Provide program support services to show case “best in class” projects using modern, efficient biomass thermal technologies • Support education, outreach, and training for architectural, building construction, insurance, real estate, and engineering professions
Lack of regulatory framework for thermal sector	• Develop comprehensive “total energy” approach including electrical, thermal, and transportation energy • Expand RPS to include thermal energy • Apply SBC to heating fuels
Expanded natural gas service into new jurisdictions	• Apply a SBC to natural gas to further fund thermal efficiency and renewables such as biomass
Expanded use of electric powered air source heat pumps	• Create policies to encourage the combined use of biomass boilers and heat pumps as back-up systems