Small Modular Biopower: Potential Energy Option for Ghana and Nearby Countries

Accra, Ghana

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Agenda

- Modular Biopower
  - Technical Details
  - Advantages
  - Comparison to other renewables
- Case Study
- Questions to be considered
- Barriers

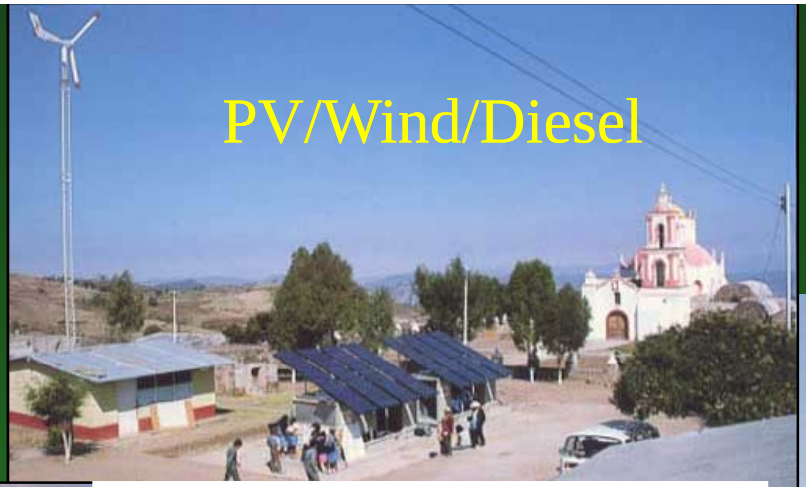
CPC's Mission

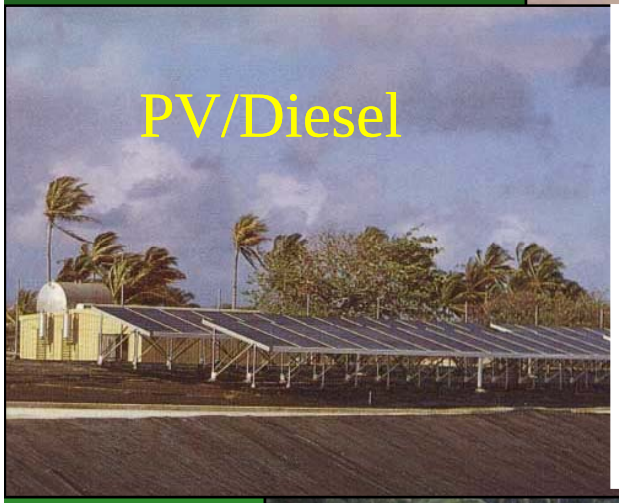
Mission:

Provide small, modular, biopower systems to the distributed generation market.

Product Development Facility
Littleton, CO

Projects Using Other Renewable Resources

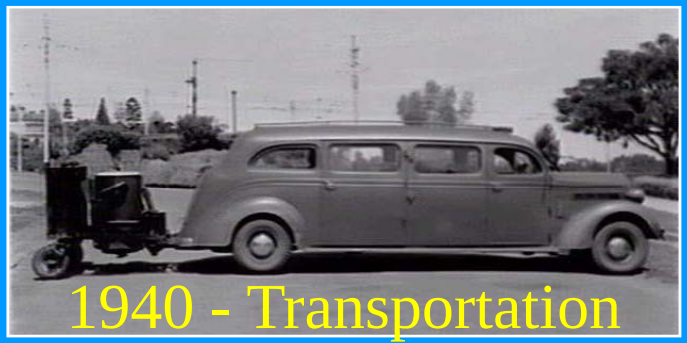




Biomass Gasification

- Process that converts organic materials into combustible gases
- History
  - 1669: first experiments in gasification
  - 1788: first gasification patent
  - 1878: first use with engines for power generation
  - 1940's: fueled one million vehicles due to gasoline shortages in Europe
  - After WWII: decreased interest due to plentiful fossil fuels
  - 1970's to now: renewed interest due to energy shortages

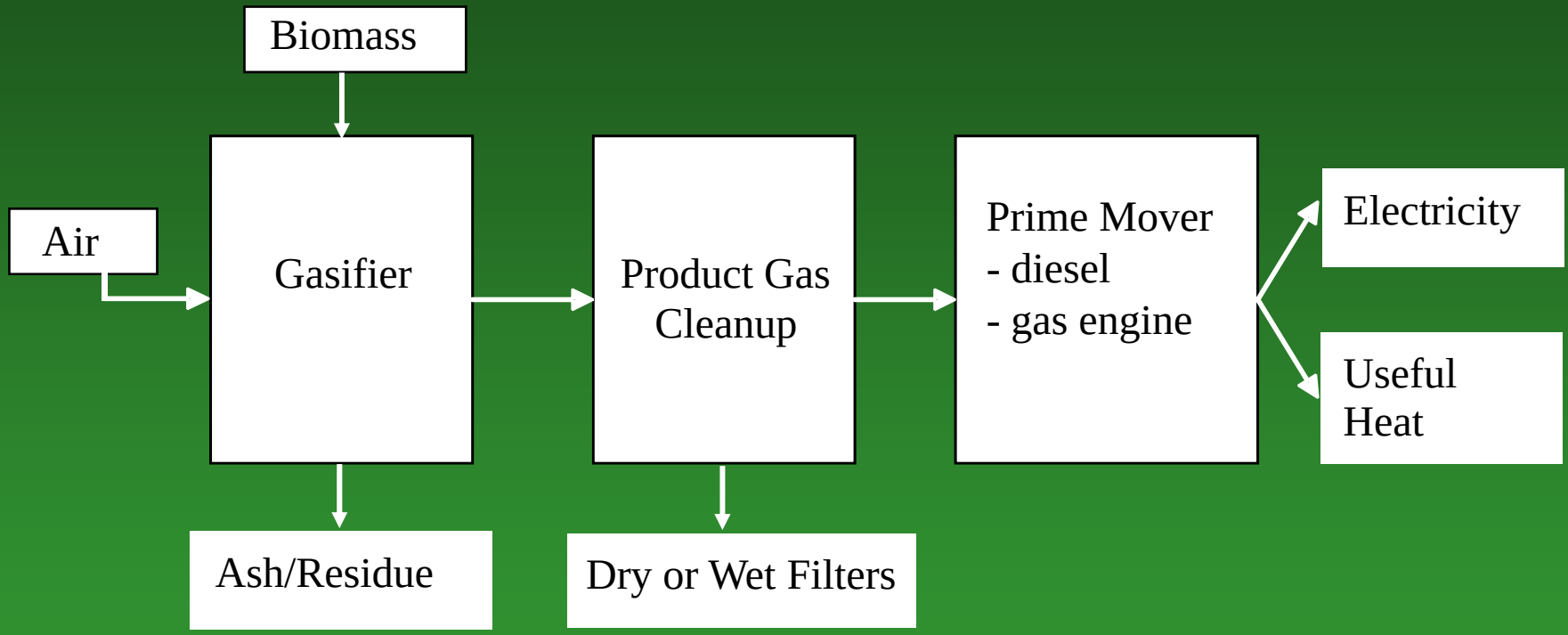
Gasifiers to Fuel Engines



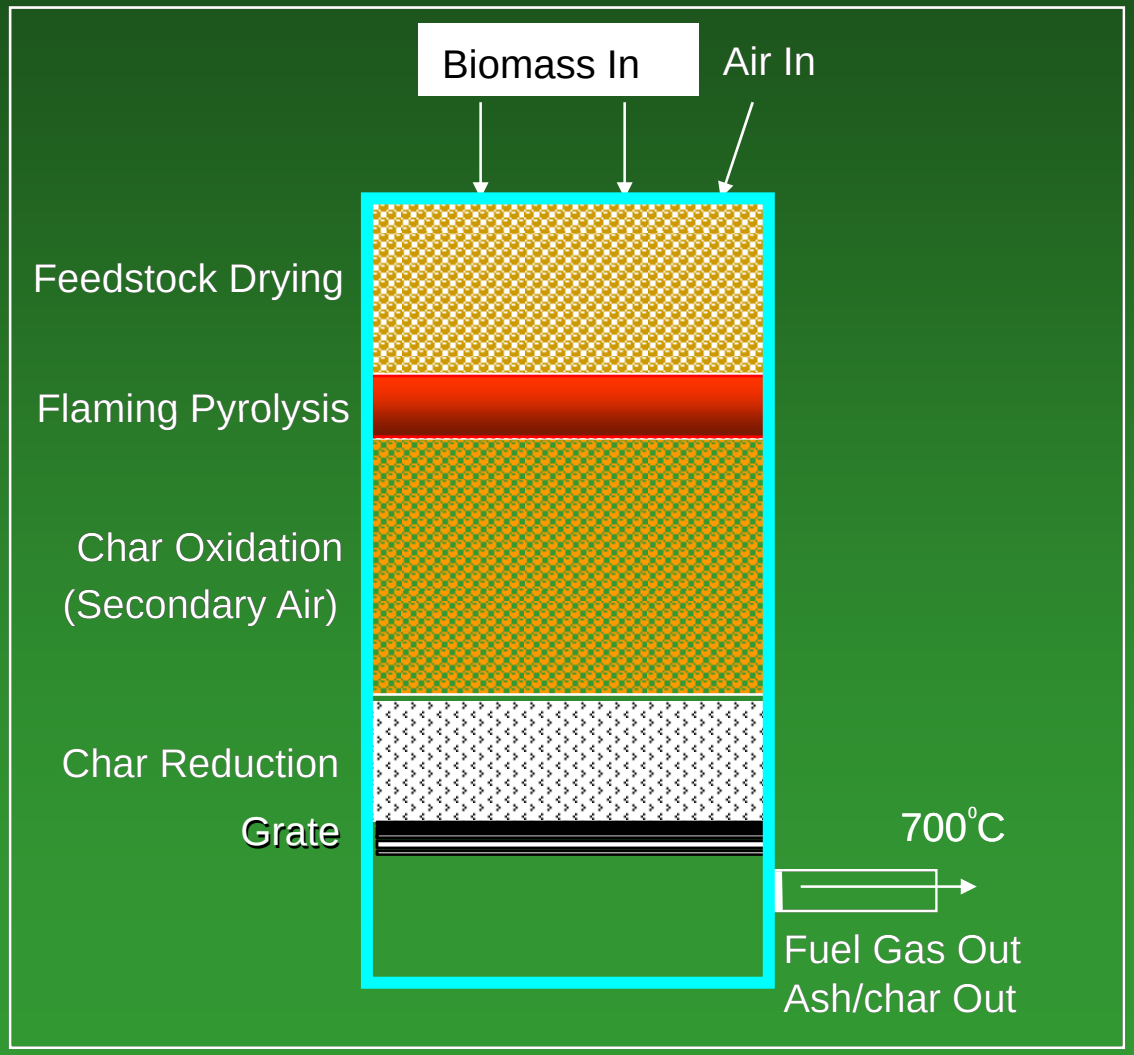
1940 - Transportation

Today - Power

Typical Modular Biopower System



Typical Downdraft Gasifier Technology



Char Oxidation:

$C + O_2 = CO_2 + Heat$

$2H_2 + O_2 = 2H_2O + Heat$

Char Reduction:

$CO_2 + C + Heat = 2CO$

$H_2O + C + Heat = H_2 + CO$

Advantages of Small Biopower

- ✓ **Uses abundant local biomass residues**
- ✓ **Creates power for on-site use**
- ✓ **Uses many types of biomass**
- ✓ **Grid quality power**
- ✓ **Easy to install**
- ✓ **Small footprint = high power density**
- ✓ **Dispatchable**
- ✓ **Cooling, heating, power = high efficiency**
- ✓ **Dual fuels**
- ✓ **Competitive against other distributed generators**
- ✓ **Standard systems, ideal for mass manufacture**
- ✓ **Some are automatic, some aren’t**

Biomass Fuels for Downdraft Gasifier

- Good
  - Wood
  - Nutshells
  - Pellets
  - Corn
  - Cubed grasses
- Difficult
  - Sawdust
  - Rice husks
  - Leaves
  - Corn Stover

Modular Biopower Is Very Flexible

Gas Production Module | Conversion Modules | Products

BioMax GPM

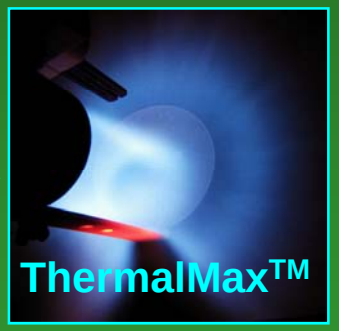
Biomass
- Residues
- Pellets

Gasifier | Gas Cooler | Gas Cleaner

Gen-set (diesel or gas)

Burner

Liquid Fuel



BioMax 25

(25 kWe and 50 kWt)

BioMax 50
(50 kWe and 100 kWt)

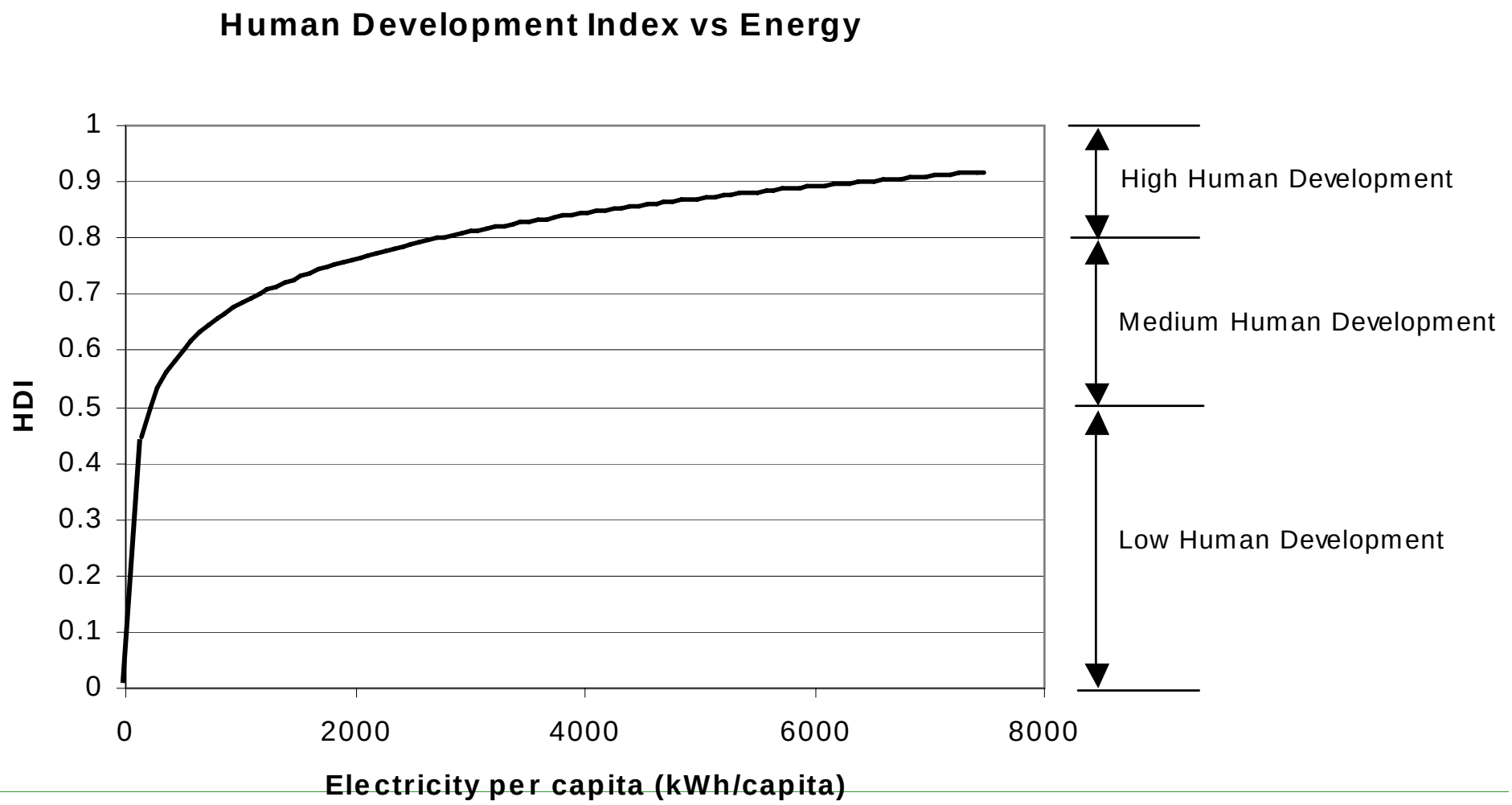
Each Renewable Technology Has Advantages/Disadvantages

	Relative Comparison of Productive Use Attributes						
Renewable Technologies	Centralized AC	Distributed DC	Capacity	Thermal	Resource Variability	Siting Flexibility	Product Availability
PV	🔴	🟢	🔴	🔴	🔴	🟢	🟢
Wind	🔴	🟢	🟢	🔴	🔴	🔴	🟢
Biomass	🟢	🔴	🟢	🟢	🟢	🟢	🔴
Hydro	🟢	🟢	🟢	🔴	🟢	🔴	🟢
Geothermal	🟢	🔴	🟢	🟢	🟢	🔴	🔴

🟢 Advantage

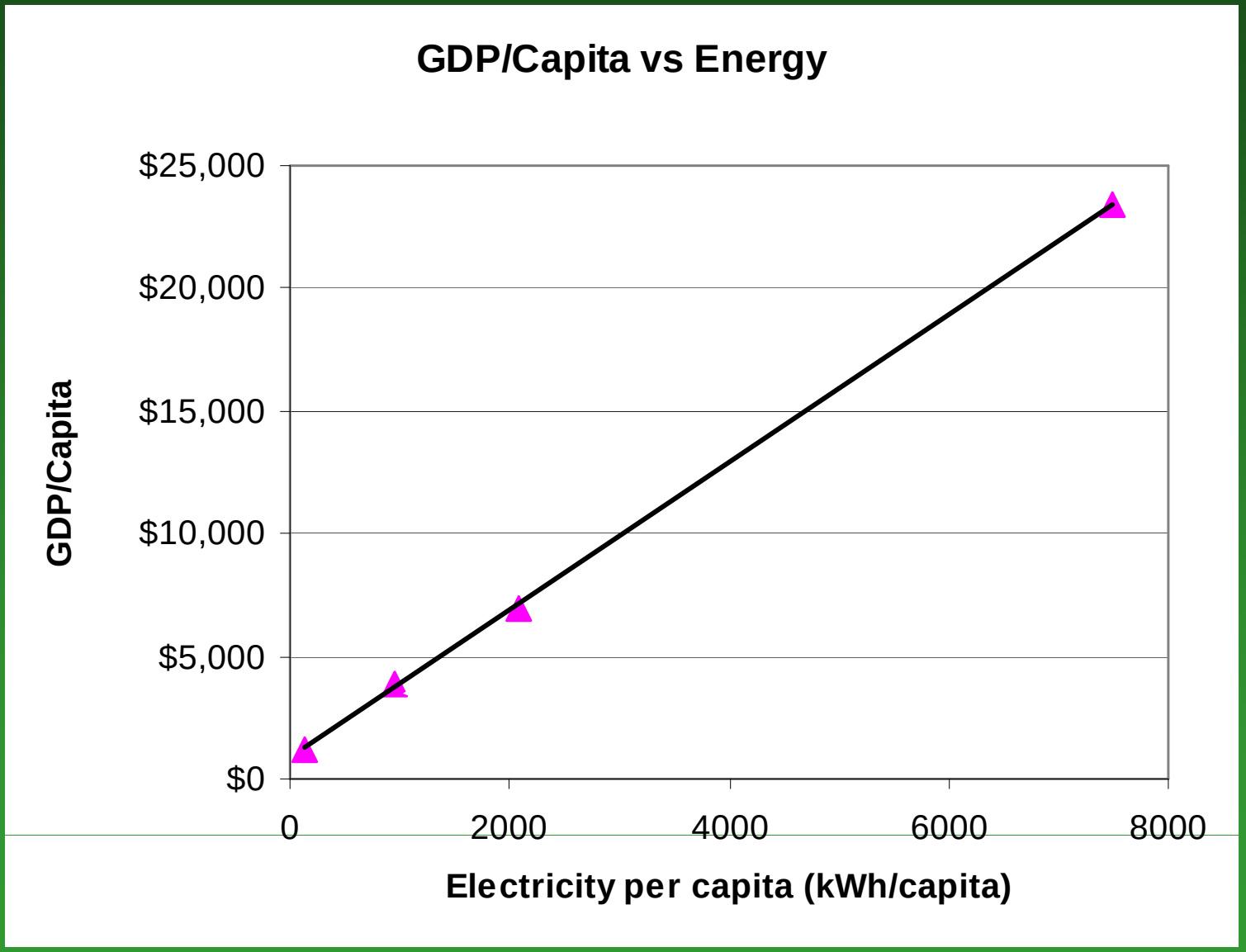
🔴 Disadvantage

Human Development Responds Dramatically to Initial Electricity Additions



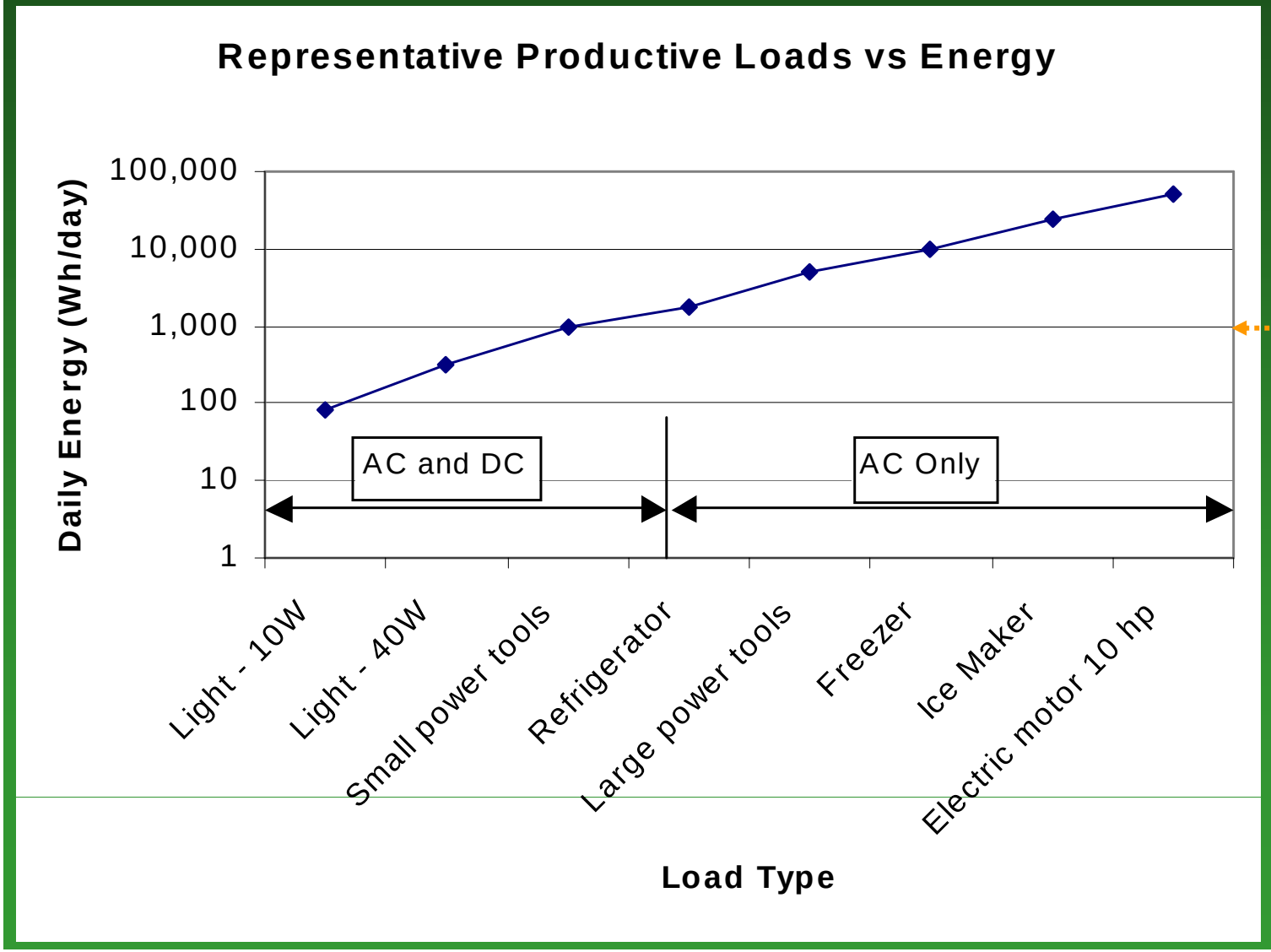
Source: UNDP Human Development Report 2001

Economic Development Increases Directly With Energy



Source: UNDP Human Development Report 2001

Productive Energy Demand Is A Function of the Number and Type of Loads

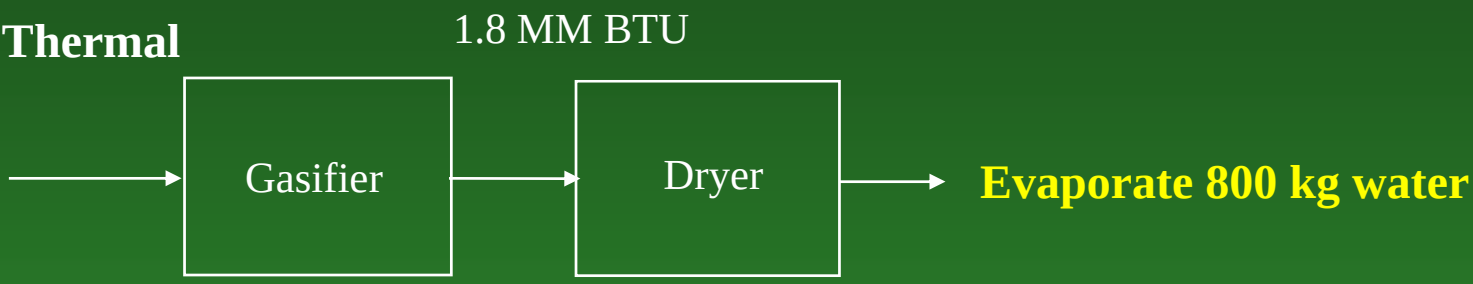


Rural Enterprise Uses Energy in Many Different Forms

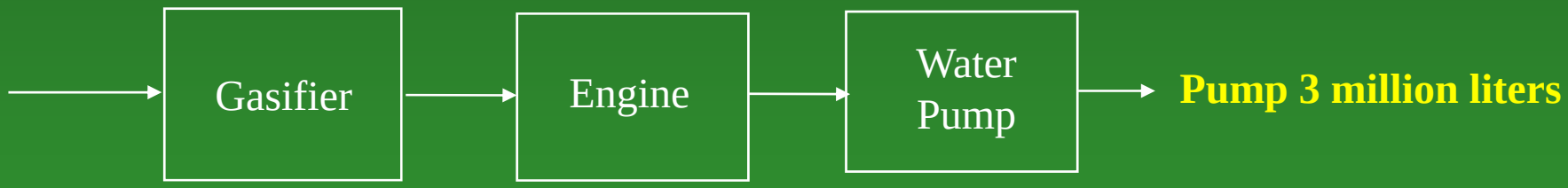
Productive Use	Form of Energy	Amount of Energy	Useful Work Performed
Dryer	Thermal	1.8 million btu	Evaporate 800kg water
Irrigation	Mechanical	46 million kg meters	Pump 3 million liters
Grinder/Mill	Electrical	200 kWh	Run 20 Hp motor 14 hrs

Biopower System: 200 kg/day Biomass Will Power Any One of the Following Options

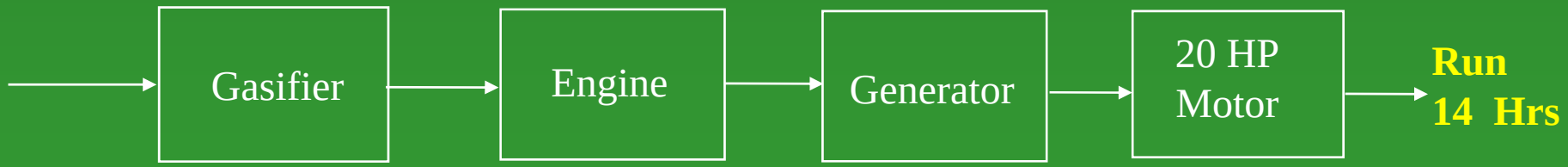
1. Thermal



2. Mechanical



3. Electrical



Small Productive Loads

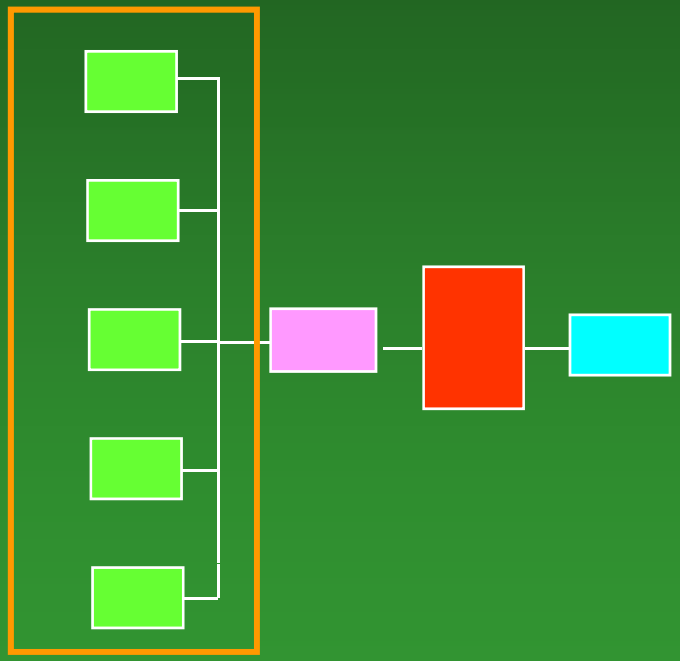
- Thermal
  - dryers
  - cold rooms
  - freezers
  - boilers
  - purifiers
  - distillers
  - cookers
- Mechanical
  - grinders
  - saws
  - mills
  - lathes
  - pumps
  - fans
  - generators
- Electrical
  - motors
  - compressors
  - pumps
  - heaters
  - welder
  - air conditioners
  - computers

Small Biomass Is Ideal For Rural Enterprise Development

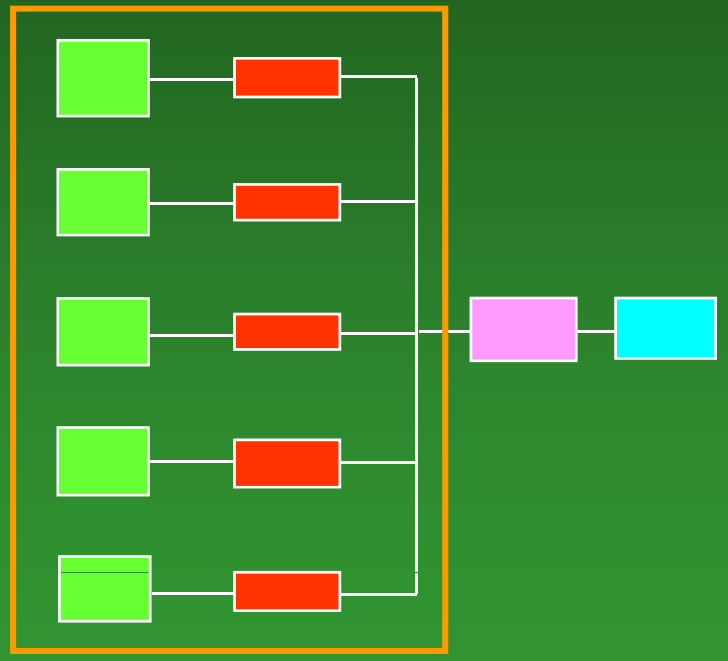
- Ag and forest residues widely available
- Power quality advantages
  - Flexible power: electrical, mechanical, thermal, and chemical
  - Grid quality AC
  - Dispatchable
- Ties directly to productive use
  - Can pay people to collect and process
  - Processing waste can be used as fuel
  - Provides both power and heat
- Can displace 85% of diesel fuel

Access to Energy Permits Local Value Creation

Traditional Approach
Processing: Centralized
Value Added: Down stream
Product: Raw material/commodity



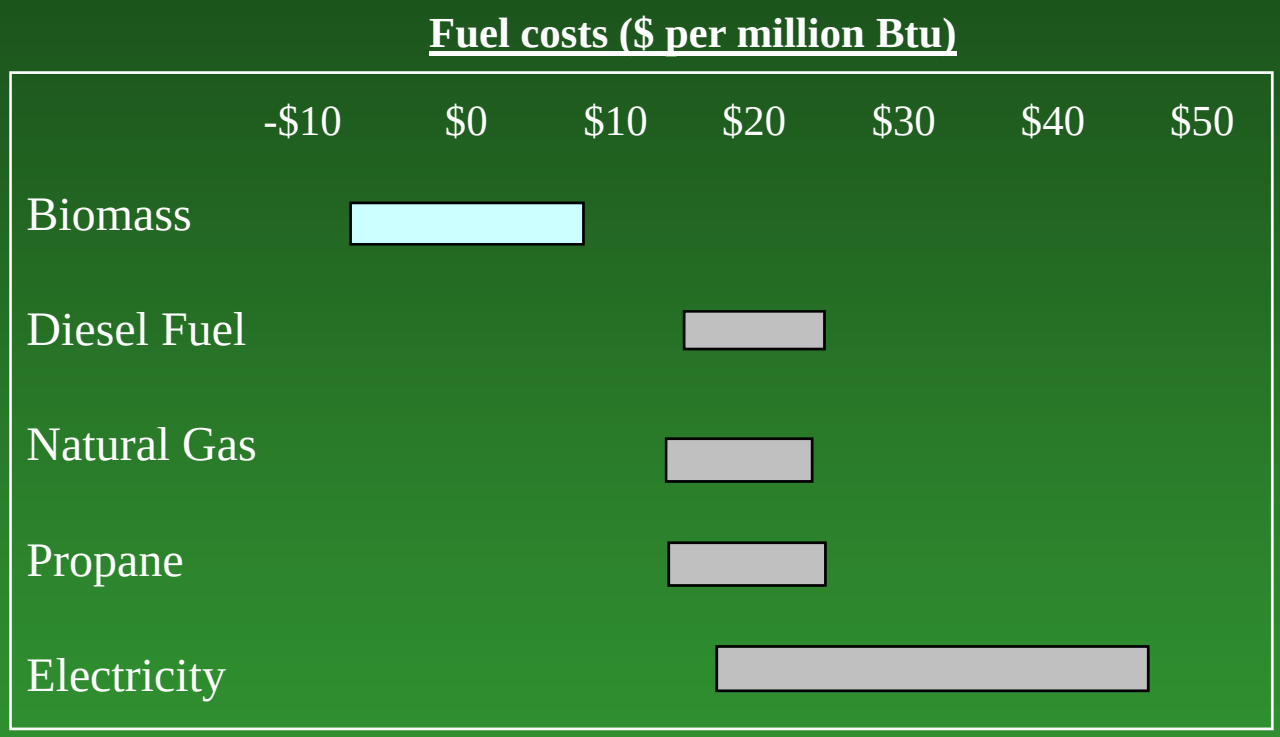
Non-traditional Approach
Processing: Distributed
Value Added: Local
Product: Finished goods



Harvest **Aggregate** **Add Value** **Distribute**

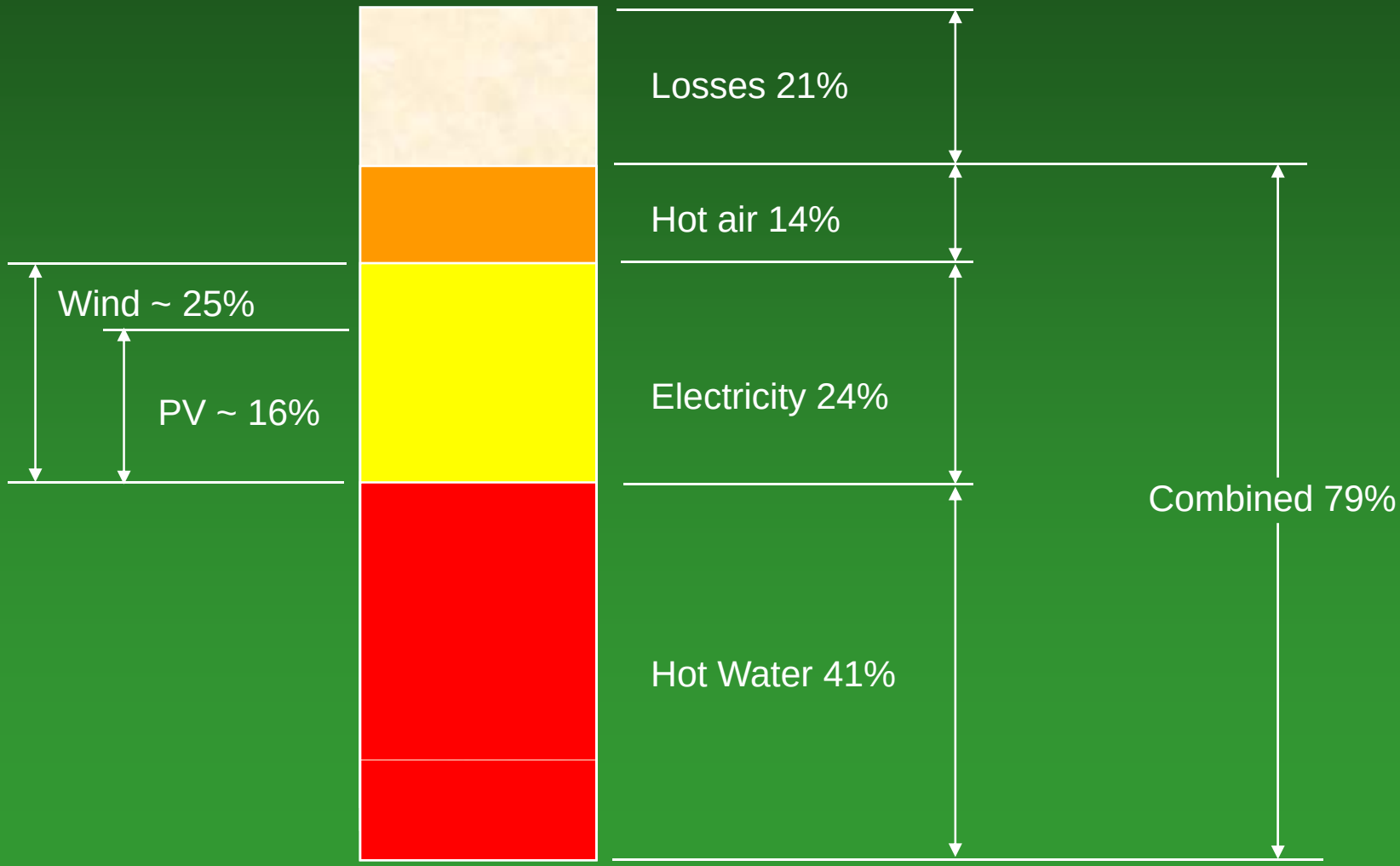
Community

Fuel Cost Savings Drive Economic Benefits



Biomass	-$50 to $150/ton (negative cost if avoiding disposal)
Diesel	$2.00 to $3.00/gallon
Natural gas	$1.00 to $1.80/therm
Propane	$1.00 to $1.50 per gallon
Electricity	$0.06 to 0.16/kWh

Modular Biopower: Highest System Efficiency of Distributed Renewables



Summary: Best Economics for Modular Biopower

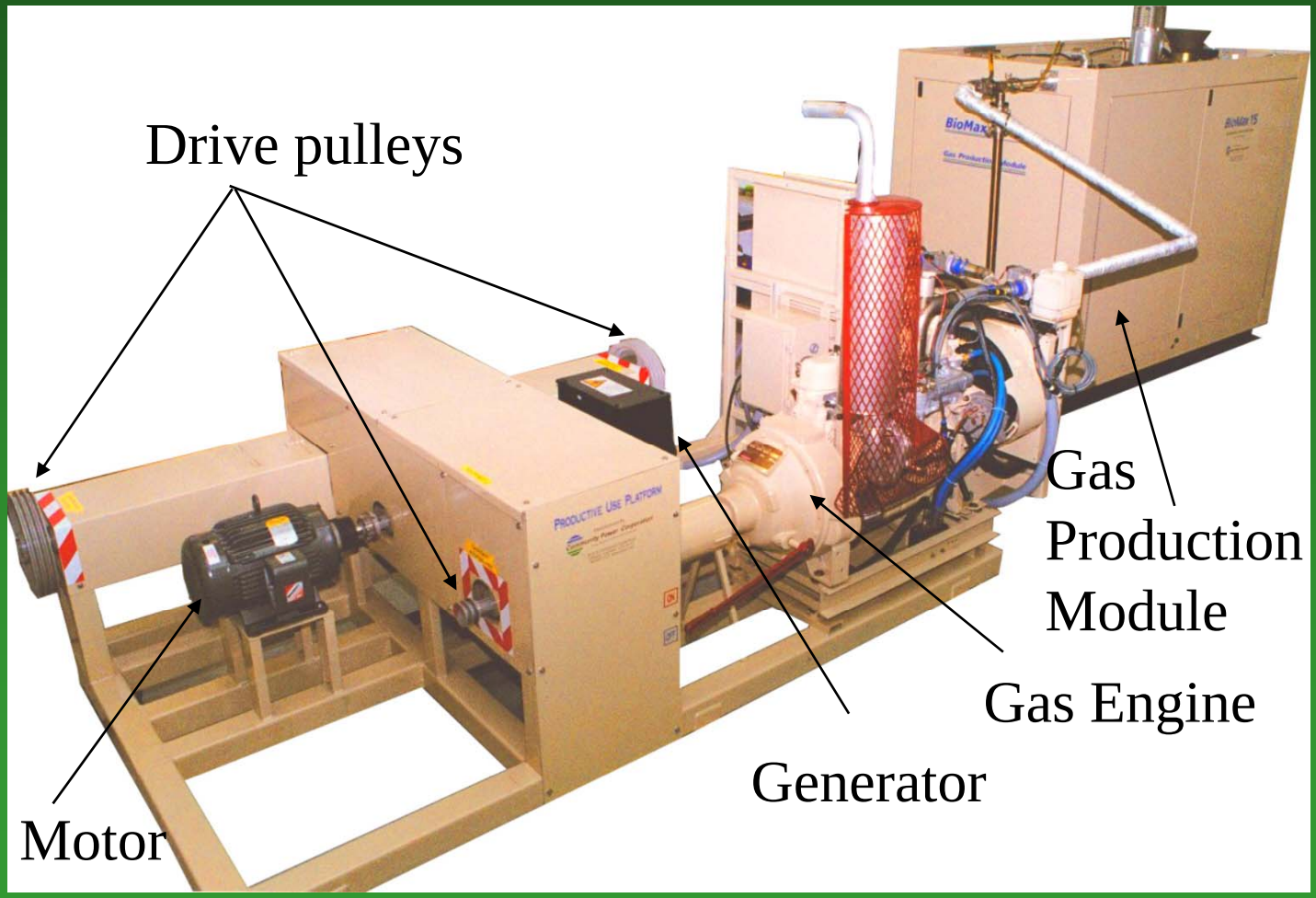
- Displace energy having high retail value
  - Electricity
  - Heat
  - Liquid fuels
- Competitive against other renewables
  - Capital cost advantage
  - Capacity factor advantage
  - Constant output
- Use low cost residue
  - At a natural collection point to avoid transport cost
  - Don’t add value to waste if possible
- Use both power and heater
- Year round thermal load

Case Study Modular Biopower for Rural Enterprise Development

- Philippines (largest coconut exporting country)
- Coconut residue (shell and husk)
  - Available at coconut processing plant
  - Husk unused, burned – environmental problem
- High level of poverty
  - Hired locals to process husk into another product
  - Used coconut shells to power system

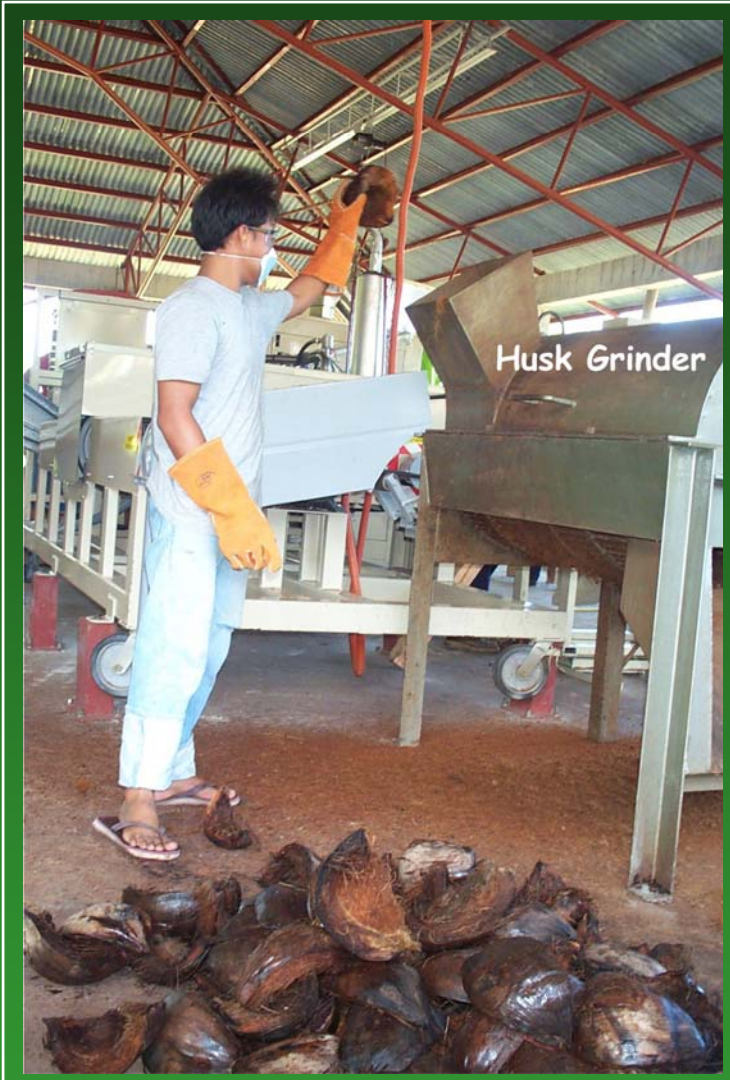
4 billion kg husks burned/yr

Community Productive Use Platform For Rural Enterprise



CPUP Deployed At Rural Philippine Coir Processing Facility

Coconut shells are ground into small chips as fuel for the BioMax



Coconut husks are soaked and then ground into fiber and dust

Fiber and dust are collected

The dust is run through a sieve to remove the small fibers

Fibers are twisted into ropes

Ropes are woven into geotextile nets

Finished nets are typically 1 meter wide x 50 meters long

Geotextile nets are placed on hillsides to prevent soil erosion

Questions to Answer Before Use of Modular Biopower

- What are the power and energy needs
  - Current uses and costs of energy?
  - Future uses and costs?
  - Load growth?
- What are the biomass options?
- Is biomass supply sustainable? (at least 3x need)
- What is the cost of the biomass (now, future)?
- Who will own system, and keep it running?
- Is the owner identified, actively involved in decision process?

Questions to Answer Before Use of Modular Biopower

- Are any permits needed?
- Does system exist or is development needed? Who will fund the development?
- Who will manufacture/supply the system?
  - Track record?
  - System performance history?
- What happens if system needs repair?
  - Warranty?
  - Spare parts (local vs imports)?

Questions to Answer Before Use of Modular Biopower

- What are environmental emissions/effluents, and do they meet local rules/regulations?
- Does system use water? If so, how much? Is water available?
- Financial considerations - costs
  - Capital
  - Operating
- Financial considerations - revenues
  - Sufficient to cover costs?
  - How secure is revenue stream?

Barriers to Modular Biopower

- New technology to the region
  - Lack of technical expertise
  - Lack of support infrastructure
- Lack of country-by country/regional biomass resource assessments
- Minimal opportunities to demonstrate, learn, improve
- Minimal innovation/action on Rural Enterprise business models
- Inertia

Words to Live By...

“Take a method and try it. If it fails, admit it frankly, and try another. But by all means, try something.”

Franklin D. Roosevelt

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