Cookstoves and Climate:

A Comparative Analysis for 2022 and Beyond

A recorded presentation to the ETHOS Conference 2022 ***www.ethoscon.com]***

Direct link to 14-minute video is *https://youtu.be/rF28B8EaoNY*

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World Reality of Cookstoves in 2022

- Worldwide roughly 1.5 billion households (HH) cook food every day.
- About two-thirds (1 billion HH) cook with modern stoves with processed fuels that are mainly based on fossil carbon deposits:
  - natural gas (NG), LPG, and most electricity. (+ some renewable (carbon neutral) solar or processed biofuels: biogas, alcohol, pellets
- About one-third **(500 million HH) are using deficient cookstoves** with minimally processed solid fuels: wood, dung, other biomass, charcoal, and some coal
- The deficient stoves produce about 2.3 percent of global CO_2 emissions,
  - virtually the same as all international aviation.
  - with many additional negatives for health, environment, drudgery, and safety.
- Cooking is essential for human life, but is also a significant contributor to increasing CO_2 emissions that are causing the climate crisis.

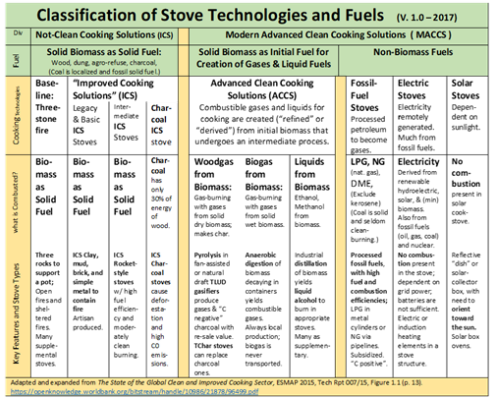
Cooking must fundamentally change soon, in your lifetime.

ESMAP Overview of Improved and Clean Cooking Technologies

http://www.drtlud.com/wp-content/uploads/2017/04/Stove-Classification-2017-04-10.pdf

2015 Original

2017 Rearranged by Anderson



Classification of Stove Technologies and Fuels (V. 1.0 – 2017)

Div	Not-Clean Cooking Solutions (ICS)				Modern Advanced Clean Cooking Solutions (MACCS)					
Fuel	Solid Biomass as Solid Fuel: Wood, dung, agro-refuse, charcoal, (Coal is localized and fossil solid fuel.)				Solid Biomass as Initial Fuel for Creation of Gases & Liquid Fuels			Non-Biomass Fuels		
Cooking Technologies	Base-line: Three-stone fire	"Improved Cooking Solutions" (ICS) Legacy & Basic ICS Stoves	Inter-mediate ICS Stoves	Char-coal ICS stove	Advanced Clean Cooking Solutions (ACCS) Combustible gases and liquids for cooking are created ("refined" or "derived") from initial biomass that undergoes an intermediate process.			Fossil-Fuel Stoves Processed petroleum to become gases.	Electric Stoves Electricity remotely generated. Much from fossil fuels.	Solar Stoves Dependent on sunlight.
what is Combusted?	Bio-mass as Solid Fuel	Bio-mass as Solid Fuel	Bio-mass as Solid Fuel	Char-coal has only 30% of energy of wood.	Woodgas from Biomass: Gas-burning with gases from solid dry biomass; makes char.	Biogas from Biomass: Gas-burning with gases from solid wet biomass.	Liquids from Biomass Ethanol, Methanol from biomass.	LPG, NG (nat. gas), DME, (Exclude kerosene) (Coal is solid and seldom clean-burning.)	Electricity Derived from renewable hydroelectric, solar, & (min) biomass. Also from fossil fuels (oil, gas, coal) and nuclear.	No com-bustion present in solar cook-stove.
Key Features and Stove Types	Three rocks to support a pot; Open fires and shel-tered fires. Many supple-mental stoves.	ICS Clay, mud, brick, and simple metal to contain fire Artisan produced.	ICS Rocket-style stoves w/ high fuel efficien-cy and moder-ately clean burning.	ICS Char-coal stoves cause defor-esta-tion and high CO emis-sions.	Pyrolysis in fan-assisted or natural draft TLUD gasifiers produce gases & "C negative" charcoal with re-sale value. TChar stoves can replace charcoal ones.	Anaerobic digestion of biomass decaying in containers yields combustible gases; Always local production; biogas is never transported.	Industrial distillation of biomass yields liquid alcohol to burn in appropriate stoves. Many as supplemen-tary.	Processed fossil fuels, with high fuel and combustion efficiencies; LPG in metal cylinders or NG via pipelines. Subsidized. "C positive".	No combus-tion present in the stove; dependent on grid power; batteries are not sufficient. Electric or induction heating elements in a stove structure.	Reflective "dish" or solar-collector box, with need to orient toward the sun. Solar box ovens.

Adapted and expanded from *The State of the Global Clean and Improved Cooking Sector*, ESMAP 2015, Tech Rpt 007/15, Figure 1.1 (p. 13).
https://openknowledge.worldbank.org/bitstream/handle/10986/21878/964990.pdf

ESMAP shows four main categories with sub-categories:

- 3-Stone Fire, (3SF) [Acknowledge recent work of Kevin McLean with stones and pits.]
- Traditional (mud; brick; metal can), (TCS)
- Improved Cookstoves (ICS)
  - many misc. types;
  - Rocket (incl some with fans);
  - charcoal

The ESMAP work with CCA endorsement is totally focused on "clean burning" (lowest emissions) cooking technology. The issues of Indoor Air Quality and human health are the only criteria for these categories.

The above are "not clean"; Those below are "clean".

- Advanced Cookstoves (ACS) (grouped by energy sources:)
  - **biomass-based**; (ABS) Advanced biomass cooking
    - (Biogas, alcohol, gasifiers / pyrolyzers (TLUD)
  - **fossil-fueled**; (AFS) Fossil fuel cooking (NG, LPG)
  - **electric**; (AES) E-cooking
  - **solar**; (ASS) (unfortunate acronym) Solar cooking

Now, today, stoves must also be evaluated about climate issues.

Distinct fuel & stove combinations can be analyzed according to key evaluation criteria

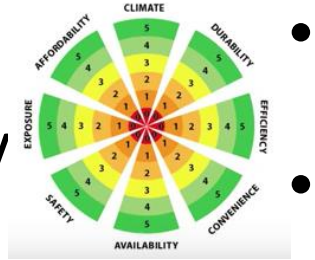
- We can use the criteria shown here minutes ago by Fox and Still:

C.L.E.A.N E.R.
Cooking Coalition

- **C**onvenient (Use)
- **L**ess emissions
- **E**fficient
- **A**ffordable
- **N**ot Harmful **(Safe)**
- **E**asy to use
- **R**obust

ISO + World Bank + ARC
8 Performance Targets

- Availability
- Exposure ("Clean")
- Efficiency
- Affordability
- Safety
- Convenience
- Durability
- **Climate**
  (incl. environment)



Eight (8)
Common names

- Available
- HH health,
- Efficient fuel consumption
- Affordable
- Safety
- User friendly
- Durable
- **Climate& Environmental impact**

- Expressed as high value (5) in graph
- Access for use
- Clean (very)
- Low fuel use (save $)
- Low net cost
- Safe to use
- User friendly
- Long lasting
- **Climate Benefits & Evironmental impact**

List of Stoves w/ Fuels based on ESMAP Categories of Cleanliness

Solid Biomass for 3SF and ICS	
3-Stone	
Traditional / Legacy ICS - Basic	
ICS – Intermediate	
ICS- Charcoal	
Solid Biomass for Advanced	
Woodgas TLUD-ND	
Woodgas TLUD-FA (Fan)	
Biogas (Anaerobic digestion)	
Liquids – Alcohols (Distillation)	
Non-biomass fuels- Advanced	
LPG & NG (Processed fossil fuel)	
Electricity (Much is fossil-based)	
Solar (Limited by daylight hours and weather)	

List of 8 Stove-Evaluation Criteria

Do you see a matrix table coming?

Matrix of stove types and their evaluation criteria

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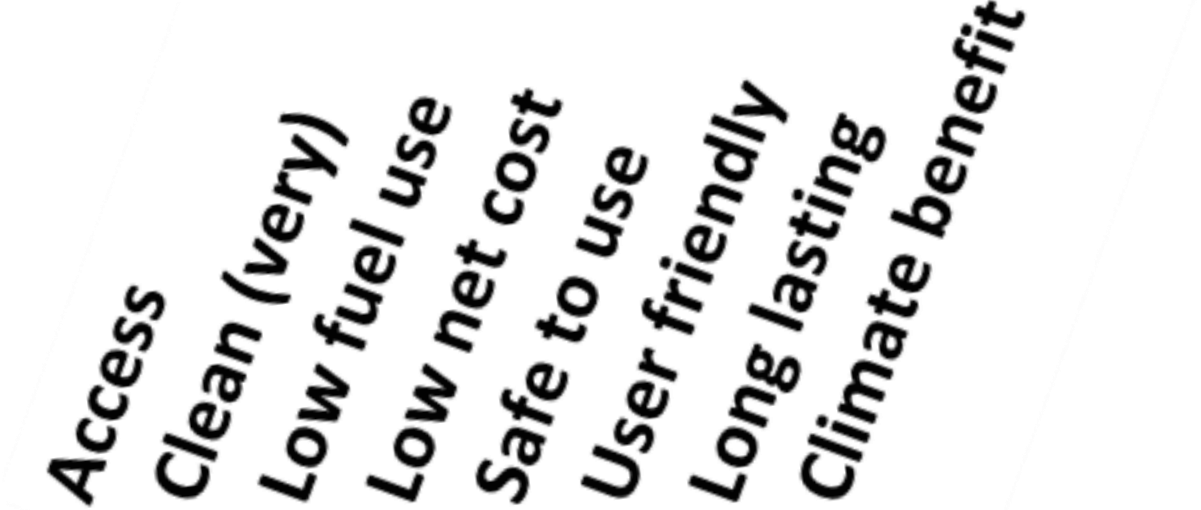

- We could rate every stove from 0 to 5 by every criteria. (Not necessary at this time.)
- We are looking for the big picture, the reality that is coming in 2050 and the fate of the world.
- We are looking for the "fatal flaws" and for any "silver linings" that should not be overlooked.

First, some guiding thoughts:

- Do not make the perfect to be the enemy of the good.
- Do not allow the inadequate to be the enemy of the good or better.
- Deal with what is possible and plausible for near-future actions.

- Paul Anderson is biased. His nickname is "Dr TLUD", based on 20 years as a "pyroneer" of pyrolytic gasifier stoves.
- Being biased does not meaning being wrong.
- Conor Fox told us: "Now is the time to be brave and be noticed."
  "Now is not a time to be sitting on the fence." "We need to be bold."

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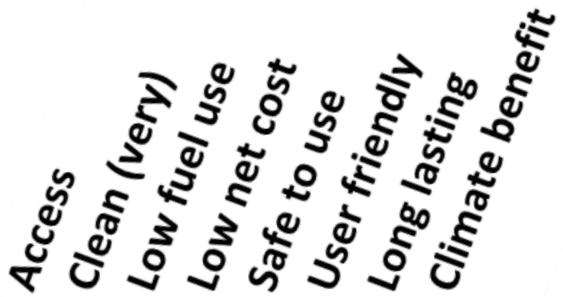
- By ESMAP and CCA determinations, all these 3SF and ICS stoves fail concerning low emissions for clean burning and health. = No CCA funds.
- Their emissions also cause them to fail regarding climate impact. They are hurting the climate.
- Being inexpensive is not sufficient.
- Would you like to depend on one in your home in 2050?

Access
Clean (very)
Low fuel use
Low net cost
Safe to use
User friendly
Long lasting
Climate benefit

Matrix of stove types and their evaluation criteria



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- **LPG and NG and fossil-based electricity** are currently attractive because of clean combustion AND lower climate impact than 3SF & ICS.
  - Fossil fuels cost too much for very poor people
  - They do cause climate-harming CO_2 emissions
  - Therefore, they must be eliminated by 2050.
- **Renewable electricity** will be in extremely high demand for priority energy needs of transportation, industry, etc. Availability for cooking will be extremely unlikely in 2050.
- **Solar cooking** has limited times and locations.

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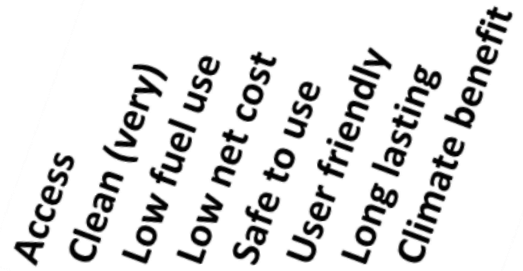

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- **Biogas** is well known as an acceptable cooking fuel in niche situations relating to supplies and handling of animal dung.
- Large biodigesters are expensive and require gas distribution systems unlikely to reach sufficient households.
- **Nature-based alcohols** (ethanol, methanol, etc.) are liquids acceptable for use for vehicles and unlikely to be available as a major HH cooking fuel. Industrial production requires specific biomass that includes foods, e.g. corn.

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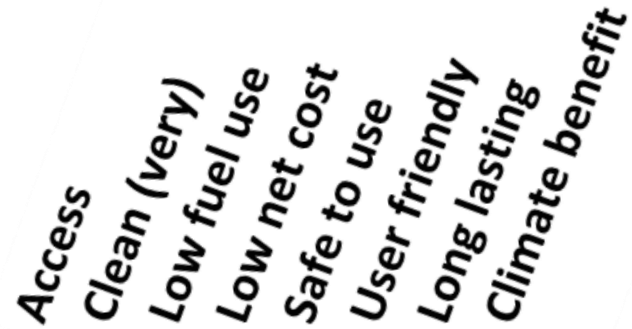


- We are running out of options. We seek solutions to possible flaws in **TLUD stoves.**
- **Fuel supply:** Biomass is abundant, diverse, and adaptable. 500 million HH currently use it, and will need 50% LESS when using TLUD devices.
- That is good for the environment/biodiversity.
- TLUDs can use pellet fuel that can be made from non-woody biomass such as crop residues, invasive species & urban "waste".

ACF
Arundo
Cellulóz Farming

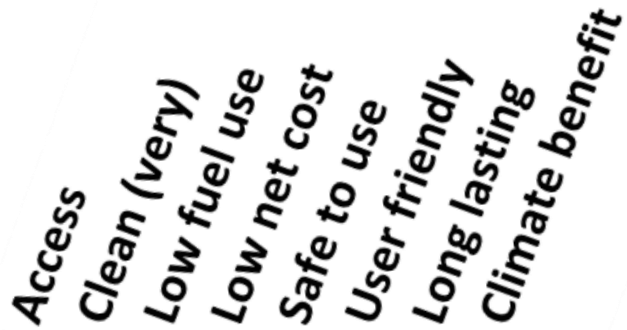
Excellent **pellet**, **"bio-bricks"**, **charcoal material**

Arundo can be adapted to your heating technology!

Features of pelleted Arundo include:

9-12 % moisture content
Protection against dump is necessary
Calorific value: 17-18 MJ/kg
Mass equals 100% of harvest

Matrix of stove types and their evaluation criteria



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- **Durability, User Satisfaction, and Safety:**
- **In West Bengal, India, over 10,000 TLUD-ND (natural draft) stoves are in their eighth year of daily use after being refurbished as part of the project's maintenance plan.**
- **Now over 100,000 are in daily use and the users express great satisfaction, in part for monetary reasons (to be discussed). Safety is not a problem.**
- **Designs can be matched to local cooking.**
- **TLUD-FA (fan assisted) offer further benefits.**

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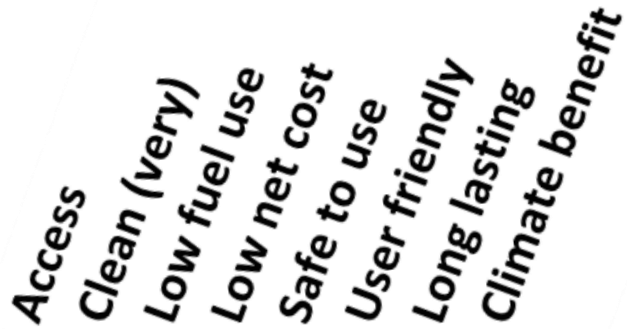

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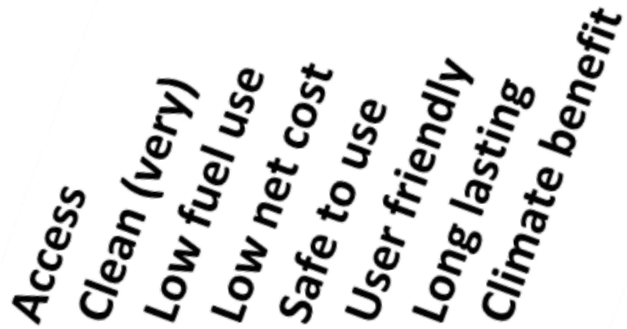
- **Cost and Access --- TLUD-ND**
- **The two major types are ND (natural draft) and FA (forced air or fan assisted).**
- **The Champion ND-TLUD with 100,000 in use costs US$40 for production in India.**
- **Existing industrial capacity could make millions more per year if orders were placed. Access only depends on financial backing.**
- **TLUD stoves actually EARN MONEY for the project, and can repay a loan. (To be discussed.)**

Matrix of stove types and their evaluation criteria



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- **Cost and Access --- TLUD-FA**
- **There are a few ~10 models of FA units in production, with various features that impact the price between ~US$50 to $250. Most use pellet fuel and a small rechargeable battery.**
- **The FA features are well worth the extra cost.**
- **The ~$50 Fabstove has been presented at ETHOS previously.**
  - **Entering into industrial production as flat-pack.**
  - **Assembly can be in local / district workshops.**

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Access
Clean (very)
Low fuel use
Low net cost
Safe to use
User friendly
Long lasting
Climate benefit

- **Climate and Environment:**
- **TLUD stoves excel because of climate issues.**
- **Pyrolytic stoves create both clean-burning woodgas for cooking and charcoal (biochar) that is true long-term CO_2 removal that biomass alone cannot accomplish.**

This is a *Silver Lining*,(almost a silver bullet??)

Carbon markets will pay for CO_2 removal.

Farming will pay for the biochar (being established)

How much benefit can come from TLUD stoves?

- I have written about the possible impacts of TLUD stoves in Section XII (pp. 21-27) in my white paper "Climate Intervention with Biochar"
- Providing TLUD stoves would contribute significant progress toward meeting eight of the UN's Sustainable Development Goals. [SDG's 1, 2, 3, 5, 6, 7, 13, and 15]
- **250 million families could sequester 0.25 Gt CO2/yr as a "by-product" of cooking daily meals** while using less of the same biomass fuel that they currently use in traditional biomass stoves, or even three times greater wood savings if transitioned from using charcoal stoves. This can be reached before 2030.
- Based on 7 years of experience in WB, India, an average household can save about US$110 per year on fuel purchases. And the women of the house receives about $40 per year from the sale of the biochar that she produces when she cooks the family meals. That is women empowerment.

Summary and Conclusion:

- We have addressed the issues. Some questions remain for discussion.
- We have found **fatal flaws in every type of cookstove except one.**
- The one flaw for TLUD stoves is **cost-related shortage of funding.** This need not be fatal if we can find financial support from the decision makers in the hyped (but unseen) trillion-dollar sectors of world economies that will grow with climate solutions. Airlines could sponsor a million TLUD stoves in countries where they do business.
- I request that those who understand the content of this presentation will **please forward this presentation** to eventually reach multi-billionaires, especially MacKensie Scott and Melinda Gates, who could individually improve the lives of hundreds of millions of the world's most impoverished women. We have proven tools, even for carbon tracking. We lack the funding.
- Opportunities with TLUD cookstoves are available to all.

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- Phone: Office: 309-452-7072 Mobile & WhatsApp: 309-531-4434

- Inventor of RoCC kilns and author of Biochar white paper: See www.woodgas.energy/resources (with biosketch on page 50.)d
- At website www.drtlud.com on the Quick Picks page are a dozen key documents and videos about TLUD stove technology

Abstract: Cookstoves and Climate: A Comparative Analysis for 2022 and Beyond

- Every day, food preparation by roughly 1.5 billion households (HH) has impact on our world's climate. About one-third (500 million HH) are using deficient cookstoves with solid fuels (wood, dung, other biomass, charcoal, and some coal). Those cookstoves are known to produce annually an estimated 2.3 percent of global CO_2 emissions, virtually the same as all global aviation.
- Cookstoves for the developing world (as analyzed by ESMAP with CCA acceptance) are in four main categories with several clear sub-categories: 3-Stone Fire, Traditional (Mud; Brick), Improved Cookstoves (ICS as Rocket; Charcoal), Advanced Cookstoves (ACS as biomass-based; fossil-fueled; electric; solar).
- Quantitative comparative analyses of 12 to 15 distinct combinations of fuel types and stove technologies are presented in relation to key factors including Cost, HH health, Fuel consumption, Environmental impact, and Climate impact.
- Clear winners and losers are revealed, with comments on financial prospects for scale-up implementation and impact on global climate issues.