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STOVE PERFORMANCE REPORT

TAO PAYAT – PTT 3
TAO DUM

SNV

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LIST OF ACRONYMS

G-BEL	GERES Biomass Energy Laboratory
WBT	Water Boiling Test
LEMS	Laboratory Emissions Monitoring System
AWBT	Adapted Water Boiling Test
CO	Carbon Monoxide
CO2	Carbon Dioxide
PM	Particulate Matter
UE	Useful Energy
TTB	Time to Boil
TTT	Time to Test
PFS	Potential Fuel Saving

ABSTRACT

The **Tao Payat–PTT 3** and **Tao Dum** stoves, produced and used in **Laos**, were received at G-BEL in March and August 2013 respectively. Both are charcoal burning stoves, the Tao Dum can also be used with wood.

Figure 1: Tao Dum

Figure 2: Tao Payat

The aim of this study is to compare the stoves performance using the **Adapted Water Boiling Test** (AWBT), a testing protocol developed by GERES. This report explains the methodology used to test the stoves and it presents a comparison of the two Lao stoves performance. The results obtained with the AWBT show that the Tao Payat can potentially save **28.5%** of fuel per cooking cycle.

In addition, standard laboratory testing was conducted to determine the performance of the **Tao Payat** stove against the ISO IWA benchmark. The stove was tested using the **Water Boiling Test** WBT 4.2.2 under the Laboratory Emissions Monitoring System (LEMS) emission hood developed by Aprovecho Research Centre (ARC).

The Tao Payat – PTT 3 - boils 5L of water in 22 minutes, uses 220 g of charcoal and 6214 kJ of energy to cook 5L. It has a thermal efficiency of 31.8% (Tier 2) during the high power phase and a specific fuel consumption of 0.004 MJ/min.L (Tier 4) during the low power phase. To cook 5L of water, the Tao Payat emits 22 g of CO (tier 4 for high and low powers and tier 3 for indoor emissions) and 439 mg of PM (tier 2 for high power and indoor emissions and tier 4 during low power phase).

INTRODUCTION

1- ABOUT GERES CAMBODIA

GERES (*Group for the Environment, Renewable Energy and Solidarity*) is a non-governmental, non-profit organization created in 1976 and specializing in the implementation of efficient energy solutions adapted to developing countries to improve the living conditions of their inhabitants.

Operating in Cambodia since 1994, the vision of GERES Cambodia is for South East Asian population to take ownership of achieving sustainable management of natural resources in their landscape and make informed decisions that lead to access to renewable energy, mitigation of, and adaptation to climate change, and improved livelihoods.

2- THE LABORATORY: G-BEL

In 2009, GERES established a biomass energy laboratory (G-BEL) in Phnom Penh, Cambodia. This testing facility was set up in partnership with the Institute of Standards of Cambodia (ISC) and the Ministry of Industry, Mines and Energy (MIME).

The initial objectives were to improve the quality of the clay material used to make stoves, and to conduct biomass analysis for improved charcoal production. During 2010 this work was expanded to include emissions testing and improvements to stove performance. The measurement of indoor air pollution was incorporated into the laboratory's expanding workload at the beginning of 2011.

3- TESTING SERVICE

G-BEL uses the Laboratory Emissions Monitoring System (LEMS) with the PM2.5 gravimetric measurement module from Aprovecho Research Center for stove performance testing. Other installed laboratory equipment includes precision scales, an oven and a muffle kiln. This equipment is used by G-BEL for a range of purposes including biomass analysis, stove testing, clay testing and ceramic material development.

The laboratory provides testing services as following:

- Characterization of biomass fuel: moisture, ash rate, volatile matter, fixed carbon content
- Characterization of ceramic materials: thermal and mechanical resistances, porosity
- Equipment performance testing: characterization and optimization of biomass combustion equipment (stove, kiln, etc.), at the laboratory and in the field
- Emission testing: CO, CO_2 and PM2.5 at the laboratory
- IAP testing: measurement of indoor air pollution (CO, PM) in the field

METHODOLOGY

1- WATER BOILING TEST AND EMISSIONS PERFORMANCE

The Water Boiling Test (WBT) is a simplified simulation of the cooking process. It is intended to measure how efficiently a stove uses fuel to heat water in a cooking pot and the quantity of emissions produced while cooking. Efficiency and emissions must be tested with the same protocol, because changes in stove operation and design affect both.

The WBT consists of three phases that immediately follow each other:

1) The **cold-start high-power** phase: the stove is at ambient temperature. The quantity of fuel to boil a measured quantity of water in a standard pot is measured. Then, the boiled water is replaced with a fresh pot of ambient-temperature water to perform the second phase.

2) The **hot-start high-power** phase is conducted after the first phase while the stove is still hot. The protocol is the same except that the stove is hot.

3) The **simmer** phase provides the amount of fuel required to simmer a measured amount of water at just below the boiling point for 45 minutes.

For **charcoal stove**, only cold-start and simmer phase are tested. Moreover, a lid is use during the entire test. As described in the guidelines for testing charcoal stove with the WBT, a part of the charcoal was removed at the beginning of the low power phase to keep in the combustion chamber the minimal quantity of charcoal to simmer during 45 minutes.

The Tao Payat stove was tested using the WBT 4.2.2 and Aprovecho WBT 4.2.2 data sheet, updated on April 30th, 2013.

2- ADAPTED WATER BOILING TEST

The Adapted Water Boiling Test (AWBT) has been designed by GERES to be **more representative of local** in-use operation and to **ease the implementation** of the test in developing countries.

The WBT is regularly revised and modified, making implementation by local technicians difficult and complex. The AWBT is easier, more precise (**less error sources**) and accessible to local development agencies and organizations working on the evaluation and dissemination of cookstoves.

The AWBT developed by GERES is favoring stoves able to operate in **high power**, the common way of cooking in the region.

This protocol is used for laboratory testing, not to define an energetic yield but to provide a comparison of fuel usage between two cookstoves: the relative difference between useful energies of two stoves when tested with the same fuel. The potential fuel saving can be calculated based on useful energies.

Unlike the WBT, in the AWBT protocol, the quantity of fuel is fixed at the beginning of the test and will be the same for all tests and stoves that will be compared.

The AWBT consists of two phases that immediately follow each other:

1) The **cold-start high-power** phase: at ambient temperature, the stove is loaded/fed with a fixed quantity of fuel to bring to a boil 3 liters of water in a standard pot.

2) The **evaporating high-power** phase consists on evaporating the remaining water until water temperature drops 3°C below boiling point.

The quantity of water evaporated during each phase of the AWBT is measured. The useful energy (UE) is then calculated. It represents the energy absorbed by the mass of water (Mw) to raise its initial temperature Ti to the boiling temperature Tb (sensible heat: Q sensible) and the energy absorbed by the mass of water evaporated (Mwe) to change its phase from liquid to vapor (latent heat: Q latent).

$$UE\ [kJ] = Q\ sensible\ [kJ] + Q\ latent\ [kJ]$$

$$Q\ sensible\ [kJ] = Mw\ [kg] * C * (Tb - Ti)\ [^{\circ}C]$$
$$Q\ latent\ [kJ] = Mwe\ [kg] * Lv$$

Where: C is the specific heat capacity = 4.18 kJ/kg.°C
Lv is the specific latent heat of vaporization = 2257 kJ/kg.°C

3- IWA Performance Tiers

In February 2012, more than 90 stakeholders from 23 countries met in The Hague to establish an ISO IWA that provides interim guidance for rating cookstoves on four performance indicators: efficiency, total emissions, indoor emissions and safety. Each of the four indicators has multiple Tiers of Performance 0 to 4 (see Appendix 1).

The following chart categozired stoves based on their different performance tiers:

Tier 0	Typical, Unimproved, 3-stone fire
Tier 1	Measureable Improvement
Tier 2	Substantial Improvement
Tier 3	Stretch Goals Which Achieve Significant, Measurable Health and/or Environmental Goals
Tier 4	Aspirational Goal

Tiers have been established for safety and for the WBT following metrics:

- High Power Thermal Efficiency
- Low Power Specific Fuel Consumption
- High Power CO
- Low Power CO
- High Power PM
- Low Power PM
- Indoor CO Emissions
- Indoor PM Emissions

4- Fuel used and starting method

For the **AWBT** and the **WBT**, traditional Cambodian charcoal at 3.6% moisture content and 68% fixed carbon was used. The charcoal was cut to have an average size of **2.5x3x5cm**. The AWBT was conducted using 400g of charcoal and the WBT was performed using 350g of charcoal.

Fire was started with 20g of small **woodchips** (average size of 0.1x0.1x10cm) at the top of the charcoal load. Few pieces of charcoal were then put around the flame. The wood was fired with a lighter (during around 1 minute). Then, after the charcoal is well lighted (around 3 minutes), the pot is placed on the stove.

Figure 4: Traditional charcoal

Figure 3: Woodchips for WBT and AWBT starting phase (average size: 0.1x0.1x10cm)

5- POT USED AND WATER QUANTITY

For the **WBT**, a flat bottom pot (28cm diameter and 15cm height) filled with **5 liters** of water was used for all tests. A lid was used.

For the **AWBT**, a flat bottom pot (24cm diameter and 12cm height) filled with **3 liters** of water was used for all tests. No lid was used.

Figure 5: Pot+lid used for WBT (left) and AWBT (right)

6- LIMITATION

To compare two stoves performances with **AWBT**, the tester must fill the two combustion chambers with the **same quantity of charcoal**.

The Tao Dum has a bigger combustion chamber than the Tao Payat:

Combustion chamber	Tao Payat	Tao Dum
Diameter	15 cm	20 cm
Height	7 cm	10 cm

The maximal quantity of charcoal that can be put in the Tao Payat is between 350 and 400g (with 400g, the Tao Payat combustion chamber is absolutely full). However, with the Tao Dum, 350g of charcoal was not enough to boil 3L of water. So, the AWBT was conducted with 400g of charcoal for both the Tao Payat and the Tao Dum even if it is not the most adapted quantity of charcoal for the Tao Payat. This is one of the **AWBT limitations**.

RESULTS AND DISCUSSION

1- WBT RESULTS

The Tao Payat stove was tested using the WBT 4.2.2 and Aprovecho WBT 4.2.2 data sheet, updated on April 30th, 2013.

The results obtained are presented in the charts below. The detailed results of the stove can be seen in Appendix 2.

1. HIGH POWER TEST (COLD START)	units	Tao Payat
Time to boil Pot # 1	min	21
Burning rate	g/min	7.08
Thermal efficiency	--	32%
Specific fuel consumption	g/liter	36.41
Temp-corrected specific consumption	g/liter	37.6
Firepower	watts	3,329
Equivalent Dry Fuel Consumed	g	180.9

2. LOW POWER TEST (SIMMER)	units	Tao Payat
Burning rate	g/min	0.70
Thermal efficiency	--	18%
Specific fuel consumption 45 min	g/liter	6.5
Firepower	watts	328
Turn down ratio	--	10.17
Equivalent Dry Fuel Consumed	g	31.4

► **Benchmark values**

The benchmark values combine the phases of cold start, hot start (when this phase is tested) and simmer into one value for the overall test. The Standard Performance Measures are derived from the specific fuel consumption and the specific emissions based on the water remaining.

The basic equation is:

5*[Specific Measure to Boil (average cold and hot starts) + Specific Measure to Simmer]

Where Measure is either fuel consumption or emissions.

BENCHMARK VALUES (for 5L)	units	Tao Payat
Fuel to Cook 5L	g	220.4
CO to Cook 5L	g	22.3
PM to Cook 5L	mg	438.8
Energy to Cook 5L	kJ	6,214
Time to Boil	min	22.0
CO2 to Cook 5L	g	589.9

► IWA Performance tiers

The emissions are characterized following the specifications of the ISO IWA. Two sets of measures are reported, one for outdoor pollution, and one for indoor pollution. For high power outdoor, the measures are specific to the amount of energy delivered to the cooking pot. For low power outdoor, they are specific to the amount of water remaining, and to the length simmer period. By using the length of the simmer period the metric recognizes that stoves that simmer for longer leave behind less water. For indoor pollution there are no power levels and the measure is specific to time.

The thermal efficiency is calculated from the ratio of the energy embodied in the water after the test, and the energy embodied in the fuel consumed during the test. The ISO IWA adds a new metric for low power fuel efficiency that is specific to water remaining and length of simmer in the same way as the low power outdoor emissions measure.

The tiers of performances defined in the ISO IWA can be seen in Appendix 1.

IWA Performance Metrics and Tiers	units	Tao Payat	
		Metrics	Tier
High Power Thermal Efficiency	%	31.8%	2
Low Power Specific Consumption Rate	MJ/min.L	0.004	4
High Power CO	g/MJd	7.13	4
Low Power CO	g/min.L	0.05	4
High Power PM	mg/MJd	244.5	2
Low Power PM	mg/min.L	0.17	4
Indoor Emissions CO	g/min	0.45	3
Indoor Emissions PM	mg/min	15.5	2

The following graphs situate the Tao Payat stove within the IWA proposed tiers in different categories: fuel use, high and low powers emissions and indoor emissions.

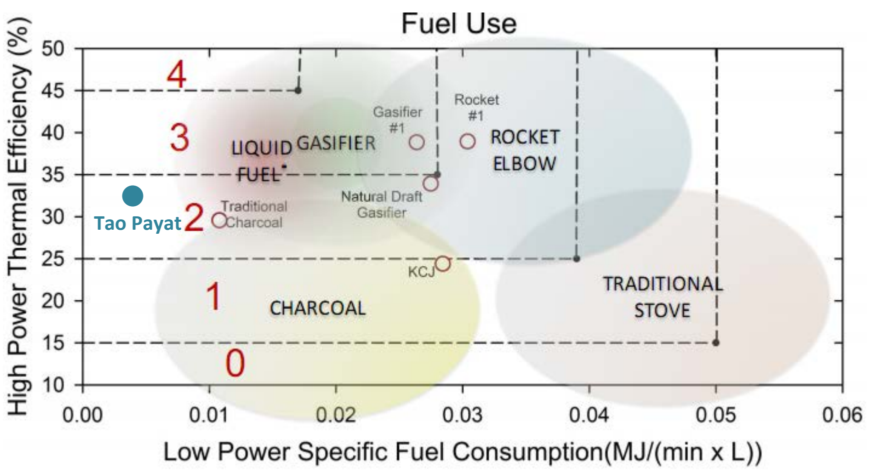

Figure 6: Fuel Use and Proposed Tiers

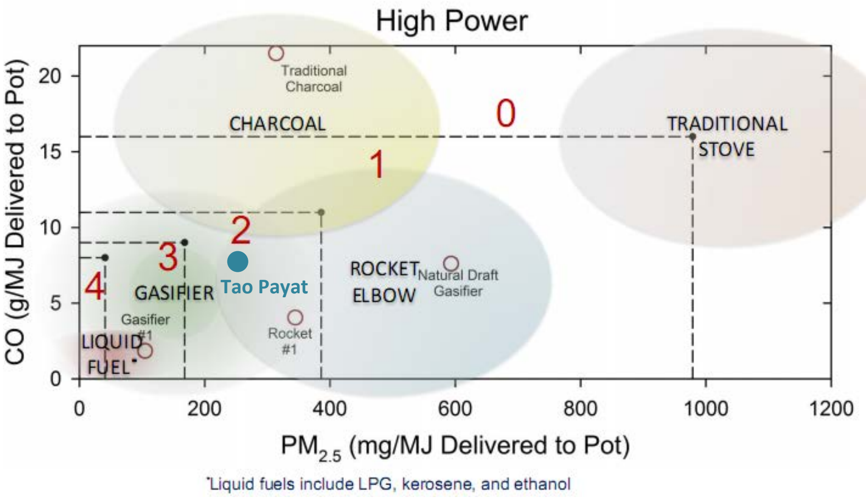

Figure 7: High Power Emissions and Proposed Tiers

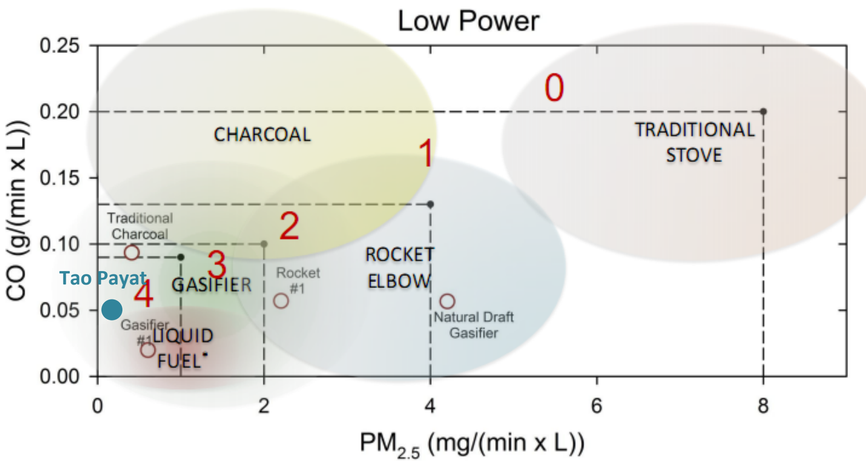

Figure 8: Low Power Emissions and Proposed Tiers

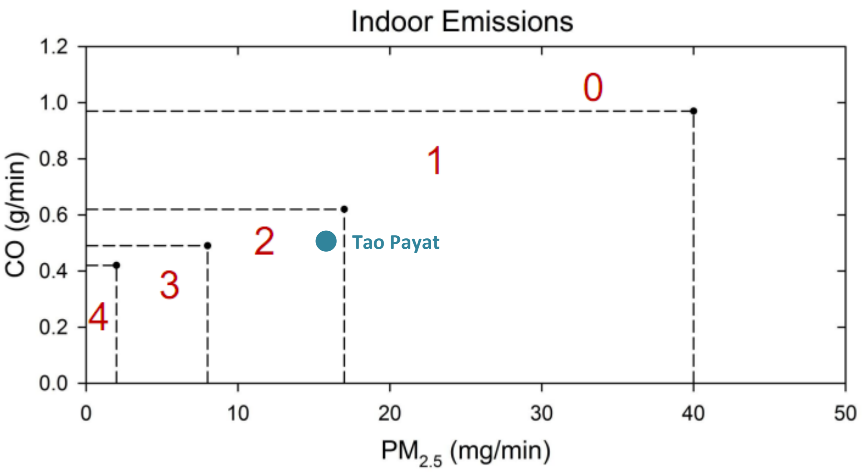

Figure 9: Indoor Emissions and Proposed Tiers

2- AWBT RESULTS

The comparison of the results obtained with the 2 stoves tested with AWBT is presented in the charts below. The detailed results of each stove can be seen in Appendix 3 and 4 for the Tao Dum and the Tao Payat respectively.

COLD START - HIGH POWER		Tao Dum	Tao Payat
M water (kg)	Mass of water	3	3
Tb (°C)	Boiling temperature	99	99
Ti (°C)	Initial temperature	28.8	27.9
Q sensible (kJ)	Sensible heat	880.726	892.012
M w after high power (kg)	Mass of water after high power	2.824	2.899
M we (kg)	Mass of water evaporated - cold start	0.176	0.101
Q latent (kJ)		397.232	228.709
UE (kJ)		1277.958	1120.721

EVAPORATING PHASE - HIGH POWER		Tao Dum	Tao Payat
Q sensible (kJ)		0	0
M w after evaporating phase (kg)	Mass of water after evaporating phase	2.357	1.950
M we (kg)	Mass of water evaporated - evap. phase	0.467	0.948
Q latent (kJ)		1054.019	2140.388
UE (kJ)		1054.019	2140.388

TOTAL TEST		Tao Dum	Tao Payat
M water (kg)	Initial mass of water	3	3
Tb (°C)	Boiling temperature	99	99
Ti (°C)	Initial temperature	28.767	27.867
Q sensible (kJ)		880.726	892.012
M w after test (kg)	Mass of water after test	2.357	1.950
M we (kg)	Total mass of water evaporated	0.643	1.050
Q latent (kJ)		1451.251	2369.098
UE (kJ)		2331.977	3261.110
TTB (hh:mm:ss)	Time to boil	0:25:29	0:19:10
TTT (hh:mm:ss)	Time to test	0:50:15	0:55:28

► **Time to boil and time to test**

The graph below shows the time to boil (TTB) and the time to test (TTT) when testing the 2 stoves with AWBT.

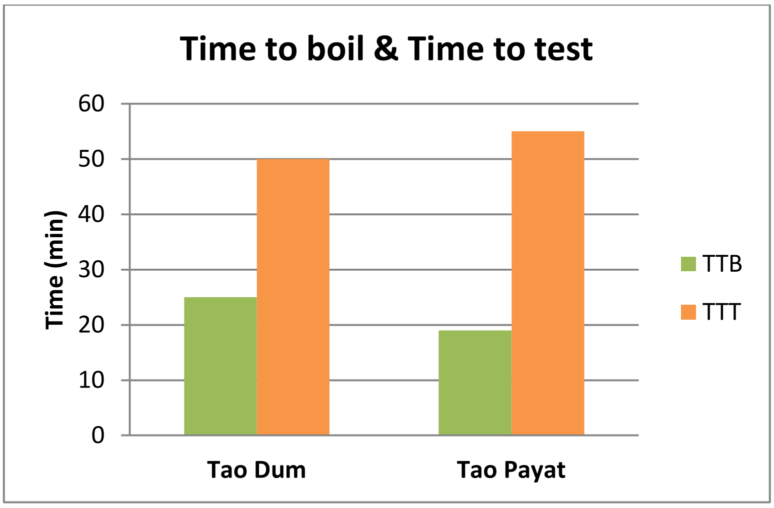

Figure 10: Comparison of TTB and TTT

With 400g of charcoal, the stove **Tao Payat** can bring 3 liters of water to a boil **faster** than the **Tao Dum** (19 minutes for the Tao Payat and 25 minutes for the Tao Dum). Moreover, with the same amount of fuel, the time to test is longer for the Tao Payat with 55 minutes, than for Tao Dum (50 minutes).

► **Useful energy (UE) and potential fuel saving (PFS)**

The potential fuel saving is the ratio of the useful energies provided by the cookstoves. This ratio shows the potential fuel differences between two cookstoves. It starts to be significant above 10%.

The potential fuel saving is calculated with the following formula:

PFS [%] = 100 *(UE improved – UE traditional) / UE improved

The useful energy calculated for the Tao Payat stove is 3261 kJ, which is much higher than for the Tao Dum (2332 kJ). As a result, the Tao Payat stove will potentially save **28.5%** of fuel compared to the Tao Dum.

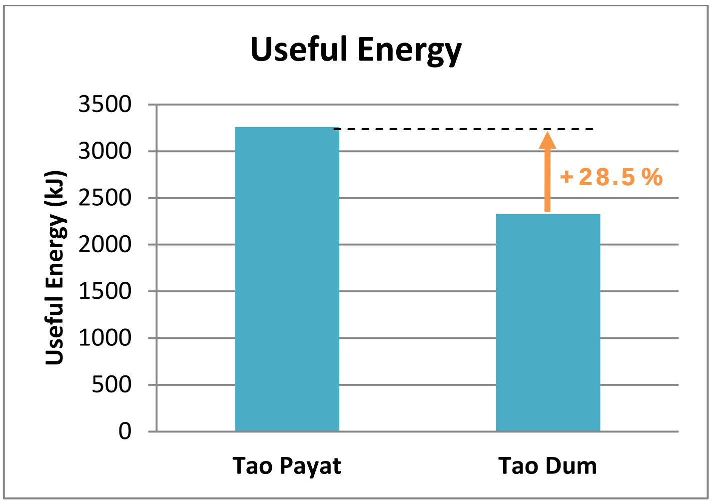

Figure 11: Comparison of useful energies and potential fuel saving

CONCLUSION

When tested with the WBT, the **Tao Payat** boils **5L** of water in **22 minutes**, uses **220.4 g** of equivalent dry wood to cook 5L and has an energy use of **6,214 kJ**. It has a thermal efficiency of **31.8%** (Tier 2) during the high power phase and a specific fuel consumption of **0.004 MJ/min.L** (Tier 4) during the low power phase. To cook 5L of water, it emits **22 g of CO** (tier 4 for high and low powers and tier 3 for indoor emissions) and **439 mg of PM2.5** (tier 2 for high power and indoor emissions and tier 4 during low power phase).

When tested with the AWBT, the Tao Payat has a potential fuel saving of **28.5%** compared to the Tao Dum.

APPENDIX

Appendix 1: ISO IWA tiers of performances

	EMISSIONS	
	High Power CO (g/MJ)	**Low Power CO (g/min.L)**
Tier 0	>16	>0.20
Tier 1	≤16	≤0.20
Tier 2	≤11	≤0.13
Tier 3	≤9	≤0.10
Tier 4	≤8	≤0.09
	High Power PM (mg/MJ)	**Low Power PM (mg/min.L)**
Tier 0	>979	>8
Tier 1	≤979	≤8
Tier 2	≤386	≤4
Tier 3	≤168	≤2
Tier 4	≤41	≤1

	EFFICIENCY	
	High Power Thermal Efficiency (%)	**Low Power** Specific Consumption (MJ/min.L)
Tier 0	<15	>0.050
Tier 1	≥15	≤0.050
Tier 2	≥25	≤0.039
Tier 3	≥35	≤0.028
Tier 4	≥45	≤0.017

	INDOOR EMISSIONS**	
	Indoor Emissions CO (g/min)	**Indoor Emissions PM (mg/min)**
Tier 0	>0.97	>40
Tier 1	≤0.97	≤40
Tier 2	≤0.62	≤17
Tier 3	≤0.49	≤8
Tier 4	≤0.42	≤2

	SAFETY
	Total Point Score
Tier 0	SUM < 45
Tier 1	45 ≤ SUM < 75
Tier 2	75 ≤ SUM < 88
Tier 3	88 ≤ SUM < 95
Tier 4	SUM ≥ 95
Poor	25 ≤ SUM ≤ 75
Fair	76 ≤ SUM ≤ 83
Good	84 ≤ SUM ≤ 92
Best	93 ≤ SUM ≤ 100

** Based on room size of 30m^3, air exchange of 15 per hour, and assuming perfect mixing

Appendix 2: The Tao Payat WBT results

Stove type/model	**Tao Payat (SNV) - Prototype 3**
Location	G-BEL
Fuel species	Charcoal

IWA Performance Metrics	**units**	**T1**	**T2**	**T3**	**Average**	**CoV**
High Power Thermal Efficiency	%	32.3%	31.4%	31.8%	31.8%	1.4%
Low Power Specific Consumption Rate	MJ/min/L	0.004	0.004	0.004	0.004	4.7%
High Power CO	g/MJd	6.49	7.39	7.49	7.13	7.7%
Low Power CO	g/min/L	0.04	0.04	0.06	0.05	21.5%
High Power PM	mg/MJd	204.9	265.8	262.9	244.5	14.1%
Low Power PM	mg/min/L	0.22	0.15	0.13	0.17	27.9%
Indoor Emissions CO	g/min	0.43	0.47	0.46	0.45	4.9%
Indoor Emissions PM	mg/min	13.5	16.8	16.3	15.5	11.5%

	Tier	**Tier**	**Tier**	**Average**
High Power Thermal Efficiency	2	2	2	2
Low Power Specific Consumption Rate	4	4	4	4
High Power CO	4	4	4	4
Low Power CO	4	4	4	4
High Power PM	2	2	2	2
Low Power PM	4	4	4	4
Indoor Emissions CO	3	3	3	3
Indoor Emissions PM	2	2	2	2
Safety				

Standard Performance Measures					**Average**	**CoV**
Fuel to Cook 5L (850/1500)	g	208.5	221.4	231.2	220.4	5.2%
CO to Cook 5L (20)	g	18.9	22.1	26.0	22.3	15.9%
PM to Cook 5L (1500)	mg	367.7	470.8	478.0	438.8	14.1%
Energy to Cook 5L (15,000/25,000)	kJ	5,879	6,245	6,520	6,214	5.2%
Time to Boil	min	20.4	22.3	23.4	22.0	7.1%
CO2 to Cook 5L	g	502.1	664.8	602.7	589.9	13.9%

Basic Operation	units				**Average**	**CoV**
COLD START						
Time to boil Pot # 1	min	20	22	23	21	6.9%
Burning rate	g/min	7.22	7.12	6.91	7.08	2.2%
Thermal efficiency	--	32%	31%	32%	32%	1.4%
Specific fuel consumption	g/liter	34.06	37.14	38.03	36.41	5.7%
Temp-corrected specific consumption	g/liter	35.2	38.2	39.5	37.6	5.9%
Firepower	watts	3,391	3,345	3,249	3,329	2.2%
Equivalent Dry Fuel Consumed	g	171.0	184.5	187.3	180.9	4.8%
SIMMER						
Burning rate	g/min	0.70	0.66	0.73	0.70	4.7%
Thermal efficiency	--	19%	19%	15%	18%	13.1%
Specific fuel consumption 45 min	g/liter	6.5	6.1	6.7	6.5	4.7%
Firepower	watts	331	311	341	328	4.7%
Turn down ratio	--	10.24	10.75	9.52	10.17	6.1%
Equivalent Dry Fuel Consumed	g	31.7	29.8	32.7	31.4	4.7%

Appendix 3: The Tao Dum AWBT results

Tao Dum

COLD START - HIGH POWER	T1	T2	T3	Average	COV
M water (kg)	3	3	3	3	
C (kJ/kg.°C)	4.18	4.18	4.18	4.18	
Tb (°C)	99	99	99	99	
Ti (°C)	30.5	28	27.8	28.8	
Q sensible (kJ)	858.99	890.34	892.848	880.726	
M w after high power (kg)	2.828	2.841	2.803	2.824	
M we (kg)	0.172	0.159	0.197	0.176	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	388.204	358.863	444.629	397.232	
UE (kJ)	1247.194	1249.203	1337.477	1277.958	4.0%

EVAPORATING PHASE - HIGH POWER	T1	T2	T3	Average	COV
Q sensible (kJ)	0	0	0	0	
M w after evap. phase (kg)	2.383	2.391	2.297	2.357	
M we (kg)	0.445	0.450	0.506	0.467	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	1004.365	1015.65	1142.042	1054.019	
UE (kJ)	1004.365	1015.65	1142.042	1054.019	7.3%

TOTAL TEST	T1	T2	T3	Average	COV
M water (kg)	3	3	3	3	
C (kJ/kg.°C)	4.18	4.18	4.18	4.18	
Tb (°C)	99	99	99	99	
Ti (°C)	30.5	28	27.8	28.76667	
Q sensible (kJ)	858.99	890.34	892.848	880.726	
M w after test (kg)	2.383	2.391	2.297	2.357	
M we (kg)	0.617	0.609	0.703	0.643	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	1392.569	1374.513	1586.671	1451.251	
UE (kJ)	2251.559	2264.853	2479.519	2331.977	5.5%
TTB	0:24:26	0:27:37	0:24:24	0:25:29	7.3%
TTT	0:48:17	0:52:44	0:49:45	0:50:15	4.5%

Appendix 4: The Tao Payat AWBT results

Tao Payat

COLD START - HIGH POWER	T1	T2	T3	Average	COV
M water (kg)	3	3	3	3	
C (kJ/kg.°C)	4.18	4.18	4.18	4.18	
Tb (°C)	99.2	99.2	99.2	99.2	
Ti (°C)	27.9	28.4	27.3	27.9	
Q sensible (kJ)	891.594	885.324	899.118	892.012	
M w after high power (kg)	2.881	2.919	2.896	2.899	
M we (kg)	0.119	0.081	0.104	0.101	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	268.583	182.817	234.728	228.709	
UE (kJ)	1160.177	1068.141	1133.846	1120.721	4.2%

EVAPORATING PHASE - HIGH POWER	T1	T2	T3	Average	COV
Q sensible (kJ)	0	0	0	0	
M w after evap. phase (kg)	1.986	1.907	1.958	1.950	
M we (kg)	0.895	1.012	0.938	0.948	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	2020.015	2284.084	2117.066	2140.388	
UE (kJ)	2020.015	2284.084	2117.066	2140.388	6.2%

TOTAL TEST	T1	T2	T3	Average	COV
M water (kg)	3	3	3	3	
C (kJ/kg.°C)	4.18	4.18	4.18	4.18	
Tb (°C)	99.2	99.2	99.2	99.2	
Ti (°C)	27.9	28.4	27.3	27.9	
Q sensible (kJ)	891.594	885.324	899.118	892.012	
M w after test (kg)	1.986	1.907	1.958	1.950	
M we (kg)	1.014	1.093	1.042	1.050	
Lv (kJ/kg.°C)	2257	2257	2257	2257	
Q latent (kJ)	2288.598	2466.901	2351.794	2369.098	
UE (kJ)	3180.192	3352.225	3250.912	3261.110	2.7%
TTB	0:19:46	0:18:51	0:18:52	0:19:10	2.7%
TTT	0:54:11	0:55:55	0:56:17	0:55:28	2.0%