

SERVE Project – Challenges, Data Collection Structure and Methodology

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Presented By PJ McLoughlin
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Project Overview

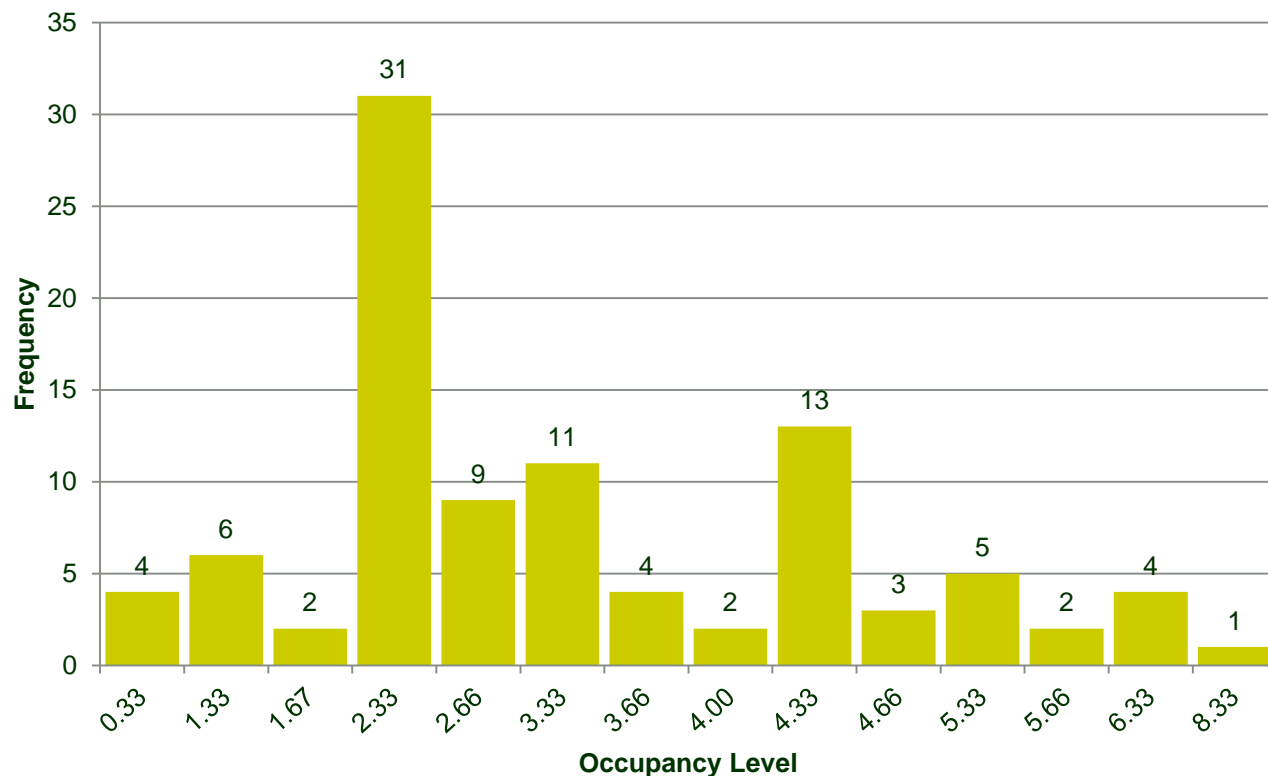


Homeowner Selection



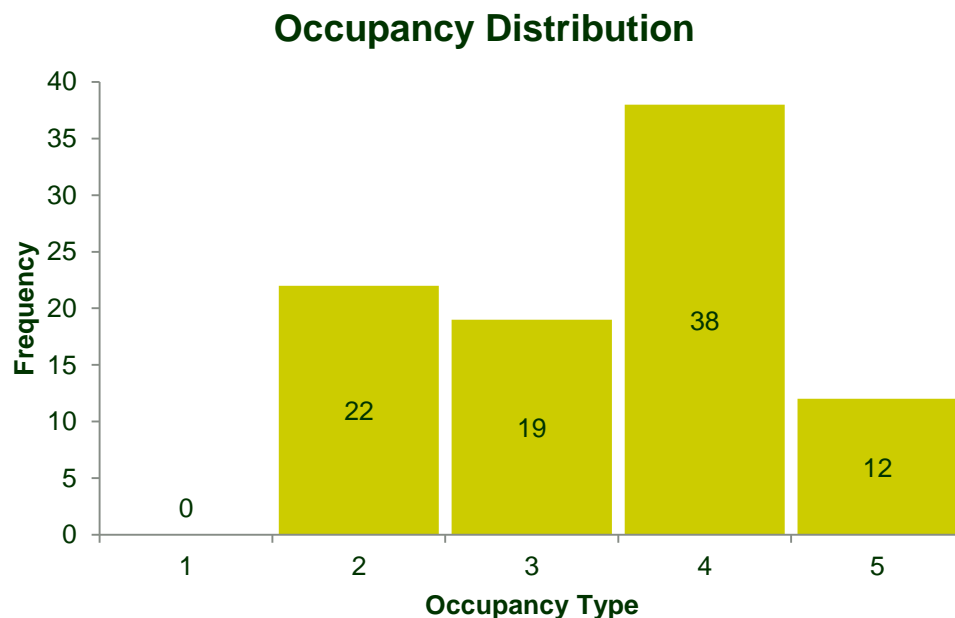
Homeowner Selection - Occupancy

- Occupancy Factor = $FTO + 0.33(PTO)$
- FTO – Full time Occupants
- PTO – Part Time Occupants









Homeowner Selection – Occupancy Type

- 5 - all of the time
- 4 - most of the time
- 3 - Evenings , weekends & some days
- 2 - Evenings and Weekends
- 1 - Only at weekends









Homeowner Selection Survey

Part 1	What type of Internet connection is in the house? (please tick the box below ✓)				
	No internet connection in the house	Wireless Mobile Modem (e.g. O2, 3G, Meteor and Vodafone) <i>Connection speeds depend on signal strength</i>	Broadband e.g. <u>Eircom</u> (without a router) <i>Fast connection.</i>	Wireless Broadband e.g. <u>Eircom</u> (with a router) <i>Fast connection.</i>	Land line (with or without internet)
					
Tick one Box ✓					

Part 4	What type of Fuse Board is in the house? (please tick the box below ✓)	
	Older type porcelain fuses	Fuse board (trip switch) (done in <u>aprox</u> past 15 yrs)
		
Tick one Box ✓		

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Homeowner Selection Survey

- Internet Connection Type (Needed WiFi)
- House Occupancy (Looking for a mix)
- Home Heating primary & secondary
- Fuse board (Looking to avoid old type)
- House Type (Semi D, Terraced, Detached two storey, Bungalow, Year Built)
- Address (Looking for mix of urban & rural)

Homeowner Selection Lessons

- Test any survey document on the least technical person you can find!!
 - Then make it clearer even if they understand it...
- In a number of cases technicians arrived at houses to install sensors to find no wifi router!
- If at all possible try to gauge/quantify homeowner level of cooperation & interest as this will be tested in some cases!!

Survey Data Overview

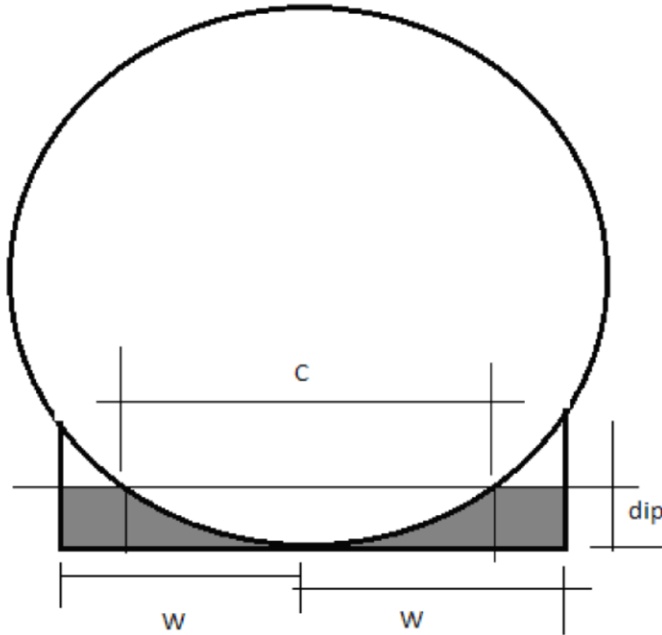
- Primary heating source: Oil consumption monitored, tanks were dipped & measured
- Oil boiler make, model, age, type
- Secondary heating source = (No. of times lit)x(surveyed fuel used per lighting instance)
- Secondary heating source per annum also = (fuel purchased per annum) {Two methods to evaluate accuracy}
- Wattage & time used for each device for desegregated electricity houses
- Scheduled to follow the installation of energy meters & sensors

Oil Tank Measure & Dip



All shapes & sizes!!

Calculus & Trigonometry



Formulas

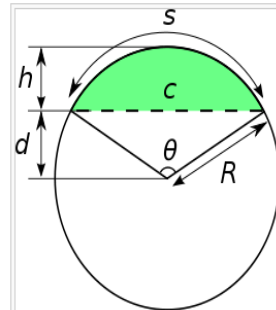
Let R be the **radius** of the **circle**, θ is the **central angle**, c the **chord length**, s the **arc length**, h the **height** of the segment, and d the height of the **triangular** portion.

- The radius is $R = h + d = \frac{h}{2} + \frac{c^2}{8h}$
- The arc length is $s = R\theta$, where θ is in **radians**.
- The chord length is $c = 2R \sin \frac{\theta}{2} = R\sqrt{2 - 2\cos \theta}$
- The height is $h = R(1 - \cos \frac{\theta}{2}) = R - \sqrt{R^2 - \frac{c^2}{4}}$
- The angle is $\theta = 2 \arccos \frac{d}{R}$

Area

The **area** of the circular segment is equal to the area of the **circular sector** minus the area of the **triangular** portion.

$$A = \pi R^2 \cdot \frac{\theta}{2\pi} - \frac{R^2 \sin \theta}{2} = \frac{R^2}{2} (\theta - \sin \theta)$$



[edit]

A circular segment (in green) is enclosed between a secant/chord (the dashed line) and the arc whose endpoints equal the chord's (the arc shown above the green area).

In **geometry**, a **spherical cap** is a portion of a **sphere** cut off by a **plane**. If the plane passes through the center of the sphere, so that the height of the cap is equal to the **radius** of the sphere, the spherical cap is called a **hemisphere**.

If the radius of the sphere is called r , the radius of the base of the cap called a , and the height of the cap called h , the **volume** of the spherical cap is then:

$$V = \frac{\pi h}{6} (3a^2 + h^2)$$

and the curved surface **area** of the spherical cap is:

$$A = 2\pi rh$$

and the radius of the initial sphere that the cap came from before it was sliced is:

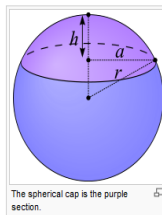
$$\begin{aligned} (r-h)^2 + a^2 &= r^2 \\ r^2 + h^2 - 2rh + a^2 &= r^2 \\ \frac{a^2 + h^2}{2h} &= r \end{aligned}$$

replacing this in the area formula gives:

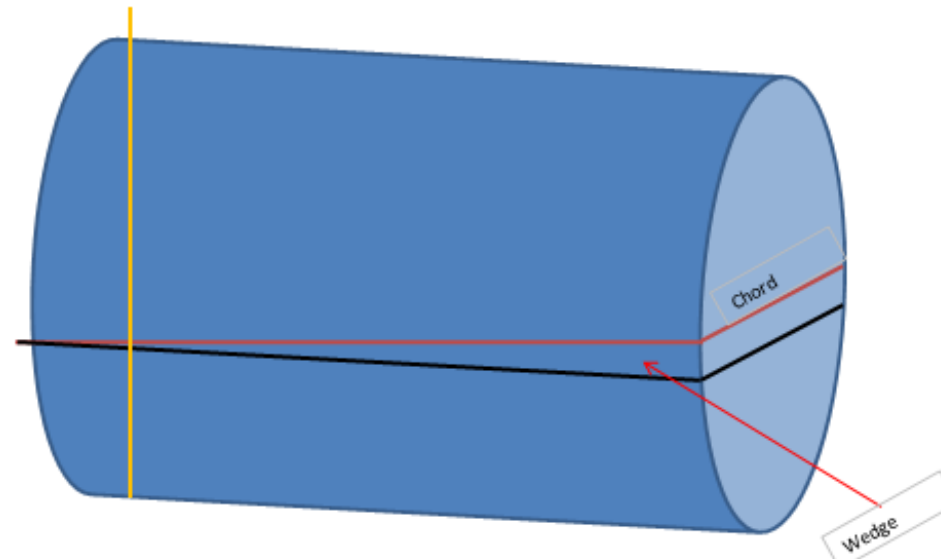
$$\begin{aligned} A &= 2\pi \frac{(a^2 + h^2)}{2h} h \\ A &= \pi (a^2 + h^2) \end{aligned}$$

Note also that in the upper hemisphere of the diagram, $h = r - \sqrt{r^2 - a^2}$, and in the lower hemisphere $h = r + \sqrt{r^2 - a^2}$, hence in either hemisphere $a = \sqrt{h(2r - h)}$ and so an alternative expression for the volume is

$$V = \frac{\pi h^2}{3} (3r - h)$$



The spherical cap is the purple section.



Primary Heat Survey & Calculations

- Primary heating:
- Oil Boiler make and model
- Oil boiler nozzle size
- Oil tank dimensions and shape
- Oil tank make and model
- Dip oil tank to calibrate

- Method of relating power meter on boiler to **dipping oil tank** twice:
- The electrical energy used by the boiler was measured over a period this was converted to a volume of oil over the same period. With these two figures the calibration factor is:
- $F = \Delta V / \Delta E \text{ (l/kWh)}$

- Conversion factor can then used in future with electrical energy use readings from the power meter at the burner.

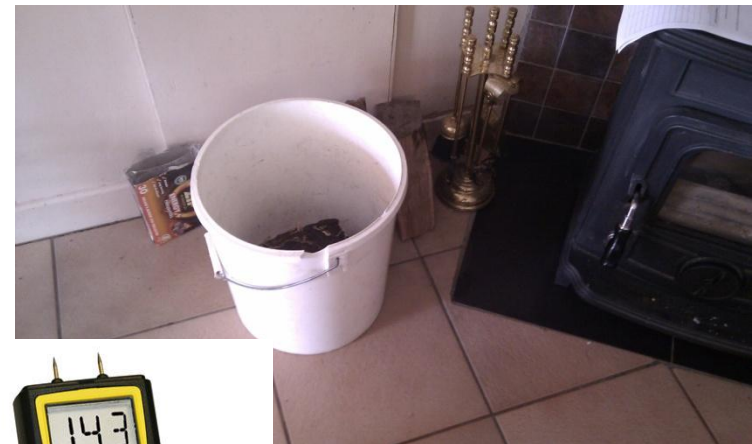
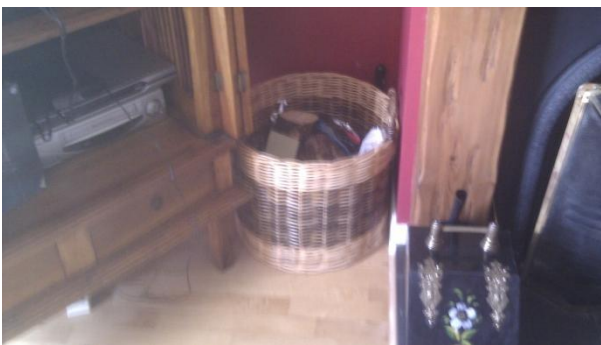
Oil Volume Lessons

- Initially planned to use manufacturer data to derive volume in tank at time 1 from a simple dip
 - Not available – Too many tank types.
- Also planned to use homeowner brim filling tank with difficult geometry tanks
 - Not possible due to cash required to fill tank
- If long time was left between dippings 1 & 2 there may have been oil delivered -> very important to collect the invoice!
 - Try to leave long enough that significant oil consumption occurred but not deliveries (if invoices will be difficult to obtain)

Secondary Heat Survey



Secondary Heat Survey



Secondary Heating Calculations

Some Examples of the sums:

Pallett of hard wood eg ash :1.1x1.1x1.5 is 1.815m³

aprox 165 euros

1.815

stacked hardwood at 20% is 453kg/m³ thus pallet 822.195kg
kWh 3362.778

Eco Briqs 10kg per pack = 50% Wood 50% Miscanthus

at 10% MC Miscanthus is 4.36kWh/kg

one bale of eco briqs 45.3kWh (12 briqs in each bale)

Table 1.7.3 Mass and bulk density of main tree species^[2]

Moisture M %	Beech			Oak			Spruce			Pine		
	m ³	Fw stacked m ³	Cw bulk m ³	m ³	Fw stacked m ³	Cw bulk m ³	m ³	Fw stacked m ³	Cw bulk m ³	m ³	Fw stacked m ³	Cw bulk m ³
Mass and bulk density in kg*												
0	680	422	280	660	410	272	430	277	177	490	316	202
10	704	437	290	687	427	283	457	295	188	514	332	212
15	716	445	295	702	436	289	472	304	194	527	340	217
20	730	453	300	724	450	298	488	315	201	541	349	223
30	798	495	328	828	514	341	541	349	223	615	397	253
40	930	578	383	966	600	397	631	407	260	718	463	295
50	1117	694	454	1159	720	477	758	489	312	861	556	354

The equivalence 1m³ roundwood=2.43 bulk m³ (volumetric index=0.41 m³/ bulk m³) of wood chips has been used. Initials: Fw=chopped log woods (33 cm, stacked), Cw=wood chips.

* Within the moisture range (M) 0-23%, the values have been calculated based on dry woody mass listed in table 1.5.3. The mass and bulk densities (with water) calculated have been corrected using the following swelling factors: beech 21.8%, oak 13.9%, spruce 13.5%, pine, 13.8%, assuming a linear variation of volume within the moisture range considered.

In order to calculate the net calorific value (MJ/kg) of wood with given moisture content (M) the following formula is used^[2]:

$$NCV_M = \frac{NCV_0 \times (100 - M) - 2.44 \times M}{100}$$

Fuel Consumption & Appliance Data (Method 1)									
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Solid fuel secondary heating appliances															
Id	Monitoring appliance y/n	Type Solid fuel – - Open fire in grate, - Closed room heater / (with/ without back boiler.) - Range cooker boiler y/n to rads [DEAP classification]	Output (kW) if available / (dims if not)	Location	Uses per week & hours used for per use						Fuel used – - House coal, - Anthracite, - Peat briquettes, - Sod peat, - Wood logs, - other (specify)	Final fuel Store (eg coal bucket) description	Quantity of fuel in full store (eg Weigh bucket or average wood logs weight or average turf sods weight)	Moisture Content of fuel in Final Store (eg beside fire / stove)	Average amount of fuel used per lighting instance of appliance Estimated by homeowner (kg)
					Off Peak (S,O,A,M)	Peak (Nov - March)	Summer (Jun - Jul)								
1															
2															
Non solid fuel secondary heating / cooking appliances															
Id	Monitoring appliance y/n	Type - Gas fire flueless, (bottled LPG) gas fire (bulk LPG), Oil room heater(with or without boiler and radiators), Electric room heater (fan/portable/ panel, convector, radiant) [DEAP classification]	Output (kW) if available / (dims if not)	Location	Uses per week & hours used for per use			If bottled LPG – How many bottles per annum	Comments						
					Off Peak (S,O,A,M)	Peak (Nov - March)	Summer (Jun - Jul)								

Secondary Heat Survey Q's

Details of secondary fuel <u>purchasing</u>						
Type (Note sub-type)	No purchases per week / month / year (preferably) <i>Mark: w / m / y, for each fuel</i>			Quantity per purchase (kg)	Quantity purchased per annum (kg)	Comments
	Off Peak (S,O,A,M)	Peak (Nov - March)	Summer (Jun - Jul)			
Wood logs (Type)						
Coal (house or anthracite)						
Turf (sod peat or peat briquettes)						
Gas Cylinder (Bottled LPG)						
Other fuel (Details) [Use DEAP classification]						

**Fuel Purchasing Data
(Method 2)**

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- Church St, Cahir
- Co. Tipperary, Ireland
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Thanks for your time. Questions??