Ministry of Science Energy and Technology
Policy Planning Development and Evaluation Division
The Research Unit
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To distinguish between the Nomenclature of "Barrels of Oil Equivalent" and "Barrels of Oil Saved"

Background

The Ministry of Science, Energy and Technology, as the ministry responsible for catering to the energy needs of the country has a responsibility to ensure that all information presented is accurate. The Research Unit in the Policy, Planning, Development and Evaluation Division, upon reviewing documents, projects and articles, has recognized that discrepancies exist in how barrels of oil saved is calculated. It was also recognized that Barrels of Oil Equivalent and Barrels of Oil Saved are two terms which have been used interchangeably in reporting how the country has benefitted from renewable energy projects. On that basis, through desk research and directly engaging persons from external agencies who report BOE and barrels of oil saved values, the unit was able to identify the calculation used locally and compare this with what is used internationally.

Since **BOE and Barrels of Oil** saved are Key Performance Indicators (KPI) used in the Energy Sector, it is important that as a ministry, MSET uses a standardized formula for calculating BOE and the amount of barrels saved. The latter is a calculation which requires the introduction of additional factors; however, it is the value that is more widely reported because it shows directly the economic benefit of energy efficiency/conservation efforts on the country. It is therefore critical that where it is reported that a certain number of barrels of oil have been saved, this reported value is accurate. This report highlights the difference in calculations and provides recommendations on how to move forward.

Definitions

BARRELS OF OIL EQUIVALENT (BOE) is a **unit or measure of energy**. It is used primarily to describe the quantity of energy that is found in one barrel of crude oil. The terminology was developed out of the need to compare different types of energy sources like crude oil, liquefied natural gas (LNG) and compressed natural gas (CNG). Since each energy source is in a different physical form but usually found together (they are formed from similar geological processes), energy companies typically have stocks composed of these mixtures. A method was therefore needed to estimate the total quantity of fuel/energy reserves and also compare across regions and companies ([i]) ([ii]) ([iii]).

BARRELS OF OIL SAVED can be considered a **unit of volume**. Also referred to in many countries as "drum". One barrel of oil is 158.99 litres (42 gallons). Barrels of oil saved, references the volume that is offset (saved) typically due to another source of energy being used or some conservation or efficiency measures.

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Context

Care must be taken to observe the differences between the use of BOE and barrels of oil saved, especially in official documents. This is particularly important because Jamaica has made significant strides towards the 30% renewables target and the reporting of these figures are carried in the media on a regular basis.

BOE and 'barrels of oil' are not interchangeable terms.

BOE in context is mostly used when referencing **reserves** of energy, particularly mixed energy.

If BOE is to be used in a document or report, it should be taken to represent an actual unit of energy. One BOE is equal to ~1700 kWh of energy (i) (ii). Therefore, if BOE is being used as a conversion for the quantity of renewable energy produced, it must be stated as a conversion and not as displacement (saved). This is because displacement calculations must include the thermal efficiency of the plant from which the energy is being replaced or avoided by the renewable energy produced.

If barrels of oil saved/avoided/displaced is to be used in a document, then the calculations must include the thermal efficiency of the plant that would normally have produced that quantity of energy. So the question must be asked *'what quantity of the 1,700 kWh of energy from the barrel of oil was converted into electricity?'* Usually the answer is approximately 35%.

1 BARREL OF OIL = 1,700kWh OF ENERGY

APPROX. 35% CONVERTED TO ELECTRICITY

Calculations

Calculation # 1 – *If WIGTON[1] produced 54,036,847 kWh of energy in 2015*

1 barrel of oil = 1,700 kWh

Then $\frac{54{,}036{,}847\ \text{kWh}}{1{,}700\ \text{kWh}}$ = *x* barrels of oil

= 31,786.38 barrels of oil

So the statement reads: WIGTON produced 54,036,847 kWh of energy in 2015 or 31,786 **BOE**.

Calculation # 2 – *If WIGTON produces 54,036,847 kWh of energy in 2015*

1 barrel of oil = 1,700 kWh

JPS overall heat rate = 9,591 kJ/kWh ([iv])

Electricity heat rate = 3412 kJ/kWh ([v])

Therefore JPS thermal efficiency $= \frac{3{,}412\ \text{kJ/kWh}}{9{,}591\ \text{kJ/kWh}}$ = 35.6%

Hence, only 35.6% of the energy dedicated to electricity production from 1 barrel of oil is converted.

Therefore, **Barrels of oil saved** = the amount of oil JPS would use to produce 54,036,847 kWh electricity

$$= \frac{54{,}036{,}847\ \text{kWh}}{[35.6\%\ of\ 1{,}700\ \text{kWh}]}$$

$$= \frac{54{,}036{,}847\ \text{kWh}}{605.2\ \text{kWh}}$$

89,287.59

So the statement reads – WIGTON produced 54,036,847 kWh of energy in 2015 or **saved 89,288 barrels of oil**.

Using the same figures, WIGTON produced **31,786 BOE** or **saved 89,288 barrels of oil**.

[1] Actual figures used for WIGTON examples

International Examples

 # 1

Table 12.18 Parameters regarding opportunity cost

Parameter	Value assigned
Price of oil per barrel	22,35 USD
Electricity production per barrel	608 kWh
MWh production of a 100 MW system	207 193
Number of barrels of oil saved	340 827
Profit margin on selling price (PMSP)	10 %
Opportunity cost = number of barrels saved × price of oil per barrel × (1 – PMSP)	7,4 MEUR

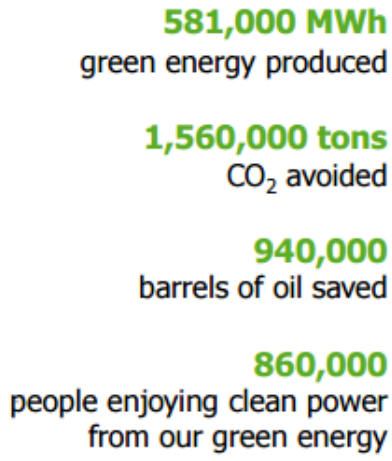
In this book ([vi]) by the **International Energy Agency (IEA)**, all the calculations are done using the estimate of 608 kWh of electricity produced from 1 barrel of oil and in turn the number of barrels of oil saved.

 # 2

Description	Savings of one 50Wp module *
Electricity saved per year	90 kWh
Electricity saved per life of PV module	2700 kWh
Barrels of oil saved over lifetime of PV module	4.8 barrels
Pounds of coal saved over lifetime of PV module	2700 lbs
Carbon Di-oxide kept out of the air over life of PV	4000 lbs
Sulfur Di-oxide kept out of air over life of PV	23.3 lbs

In this example from the **Government of Nepal**, 1 barrel of oil produces 2700/4.8 = 562.5 kWh due to 33.1% thermal efficiency ([vii]).

 # 3

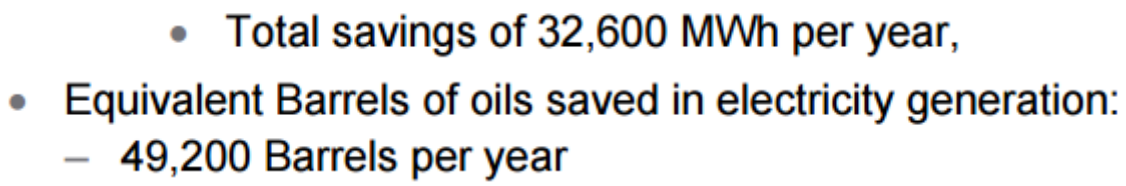


In this example from **TOTEM Energy srl**, 1 barrel of oil produces 581,000,000/940,000 = 618.1 kWh due to 36.4% thermal efficiency ([viii]).

 # 4

In this report ([ix]) by the **US Army Corps of Engineers**, all the calculations are done using the premise that 1 barrel of oil produces 560 kWh of electricity, at 32.9% thermal efficiency.

 # 5



In this publication from the **Bahamas** ([x]), 1 barrel of oil produces 662.6 kWh of electricity at 39% thermal efficiency.

From all these examples, including the **thermal efficiency of electricity production** is integral to calculating the true barrels of oil that renewable energy projects offset. Notice that no document uses 1700 kWh as the conversion factor.

Examples from the Ministry of Science Energy and Technology

 # 1

> population. To this end in 2015 the PCJ responded to the Office of Utilities Regulation's (OUR) call for up to 37 megawatt (MW) of electricity generation from renewable energy sources. Our bid proposed building a 2 MW hydro plant at the Laughlands Great River in St. Ann which studies indicate has the potential to supply up to 2 megawatt peak (MWp) and an annual average of 13,002 megawatt hour (MWh) of energy output to the national grid. This will cause Jamaica's oil demand to decrease by close to 7,800 barrels per annum and also result in a reduction of emission of over 1,000 tonnes of CO_2 each year.

This was taken from the Ministry Papers 2015/16. The calculation does not factor in the thermal efficiency associated with electricity production. The correct figure would be **21,484** barrels of oil offset, or 7,800 **BOE**.

 # 2

> "The 80.30MW of renewable energy added to the grid represents a reduction of 413,781 barrels of oil imported per year," the ministry said via email.

This was taken from a Gleaner article ([xi]) and not only shows the absence of the thermal efficiency factor for JPS electricity production, but also an incorrect calculation of using:

[80.3 MW x 24 (hrs.) x 365 (days)] / 1,700 kWh

There are three problems here:

1. The calculation mixed wind and solar energy (thermal efficiency of each plant differs)
2. There was no capacity factor included in the calculation
3. No JPS thermal efficiency factor for electricity production

 # 3

> Wigton III is expected to have an output of 63,072 megawatt hours (MWh) per year and cut annual oil imports by 37,100 barrels. It will also trim some $214 million from

This example was taken from the Jamaica Observer ([xii]), and shows that the claim being made is the offsetting of 37,100 barrels of oil. It however did not factor in the JPS thermal efficiency factor for producing electricity.

Recommendations

1. It is recommended that a standard formula be developed and stored in the format of an excel calculator. Considering that all the relevant data are available for all parts of the formula, an accurate template can be developed which only needs the energy produced/saved from the respective measure to be inputted. This yields the accurate value for barrels of oil saved/avoided and prevents human calculation errors.

2. Capacity factor for the respective plants and JPS thermal efficiency for electricity production should be added to the formula/calculator.

3. BOE should be used when **referencing** the quantity of renewable energy produced or used to group different sources of renewable energies (as is the standard practice worldwide) for easy comparison.

4. 'Barrels of oil saved' should only be used when trying to show the actual savings that the country has gained from these renewables or conservation efforts. JPS thermal efficiency for electricity production **must** be included in this calculation.

When correctly used, the true calculations result in a significant increase in the actual barrels of oil being offset by the various renewable plants established.

The Research Unit has created the calculator necessary for computing these values which is available in a separate Excel spreadsheet.

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[xii] Wigton saving the country billions in oil imports, cutting carbon emissions
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