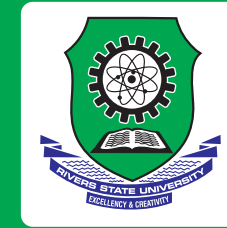


**RIVERS STATE UNIVERSITY,  
PORT HARCOURT**



**SUSTAINABLE ELECTRICITY  
GENERATION IN NIGERIA:  
OF ENTHALPY, ENTROPY, EXERGY  
AND ALL THAT, NOT POLITICS**

**AN INAUGURAL LECTURE**

By

**PROF. HOWELLS IDAEREFAGHA HART**

*BEng. (MechEngrg.) University of Benin; M.Sc. (MechEngrg.) Oklahoma State  
University; PhD (Mech. Engrg.) University of Nigeria, FNSE, FNIMechE*

**Professor of Mechanical Engineering  
(Thermo-Fluids)**

**SERIES NO. 53**

**Wednesday, 14th February, 2018**



ISBN 978-978-50620-5-2

**SUSTAINABLE ELECTRICITY  
GENERATION IN NIGERIA:  
OF ENTHALPY, ENTROPY, EXERGY  
AND ALL THAT, NOT POLITICS**

AN

**INAUGURAL LECTURE**

BY

**PROFESSOR HOWELLS IDAEREFAGHA HART**

*BEng. (MechEngrg.) University of Benin; M.Sc. (MechEngrg.)  
Oklahoma State University; PhD (Mech. Engrg.)  
University of Nigeria, FNSE, FNIMechE*

***Professor of Mechanical Engineering  
(Thermo-Fluids)***

**Series No. 53**

WEDNESDAY, 31ST JANUARY, 2018.

*Dedication*

---

This work is dedicated to the loving memory  
of my Late Parents.

**MR. EZEKIEL BIEDIMA HART**

**AND**

**MRS. JANET FURO HART**

---

## ■ TABLE OF CONTENTS ■

		Page
Dedication	-	ii
Table of Content	-	iii
List of Tables	-	vi
List of Figures	-	vii
1.0 Preamble	-	1
2.0 Introduction	-	6
2.1 The Concept of Energy	-	6
2.2 Manifestations of Energy	-	10
2.3 Economics of Energy	-	16
2.4 Energy Sources	-	17
2.5 Energy Resources	-	18
2.5.1 Fossil Fuels	-	20
2.5.2 Hydropower	-	20
2.5.3 Solar Energy	-	21
2.5.4 Biomass	-	21
2.5.5 Wind	-	22
2.6 Energy Conversions	-	23
3.0 The Laws of Thermodynamics	-	29
3.1 The First Law of Thermodynamics (FLT)	-	30
3.2 The Second Law of Thermodynamics (SLT)	-	33
3.3 Exergy	-	36
3.4 Exergy And Energy	-	40
4.0 Electricity Generation in Nigeria	-	43
4.1 History of Electricity in Nigeria	-	43
4.2 Electricity Generation Infrastructure Status	-	50
4.3 Electricity Consumption Profile	-	57
4.4 Electricity Delivery in Nigeria and Politics	-	61
4.4.1 Creation of NEPA	-	61
4.4.2 Siting of Generating Stations	-	62
4.4.3 The Mambilla Hydro Project	-	65
4.4.4 Management Position Appointments	-	66
4.4.5 Redundant Policies, Plans and Programmes	-	68
4.4.6 Flawed Privatization Process	-	69
4.4.7 Lack of Proper Co-ordination	-	70
4.4.8 Rivers State Example	-	71
5.0 My Contributions	-	74

	<u>Page</u>
<b>5.1 Of Enthalpy, Entropy, Exergy...</b>	- 76
<b>5.1.1 Gas Turbine System</b>	- 78
<b>5.1.1 Maintenance Schedule</b>	- 85
<b>5.1.2 Steam Turbine System</b>	- 86
<b>5.1.3 Hydro Turbine System</b>	- 90
<b>5.1.4 System Performance Analysis</b>	- 94
<b>5.1.5 Stemming Frequent System Collapse</b>	- 96
<b>6.0 Recommendation and Conclusion</b>	- 99
<b>7.0 ACKNOWLEDGMENT</b>	- 101
<b>REFERENCES</b>	- 113
<b>APPENDIX</b>	- 119
<b>INAUGURAL SONG</b>	- 121

## ■ LIST OF TABLES ■

	<u>Page</u>
<b>Table 2.1: Primary Energy Mix in Nigeria as at 2015</b>	- 19
<b>Table 4.1: Electricity Generating Plants before PHCN</b>	- 48
<b>Table 4.2: Generating Stations in Nigeria</b>	- 52
<b>Table 4.3: Electricity consumption profile of selected countries</b>	- 58
<b>Table 4.4: Facts about Major Generating Stations (1992)</b>	- 60
<b>Table 5.1: Power and Work Ratios for 300k and 288K</b>	- 83
<b>Table 5.2: System Performance Analysis</b>	- 95

## ■ LIST OF FIGURES ■

	Page
<b>Figure 2.1: Some Typical Energy Conversion Systems</b>	- 25
<b>Figure 4.1: Electricity Generation Infrastructure Status</b>	- 51
<b>Figure 4.2: Thermal GENCOs weighted performance for Q2, 2016</b>	- 55
<b>Figure 4.3: Hydro GENCOs Weighted performance for Q2, 2016</b>	- 56
<b>Figure 4.4: Funding Patter in the Nigeria Electricity Industry</b>	- 71
<b>Figure 5.1(a): Schematic Diagram of a Simple Gas Turbine Plant</b>	- 79
<b>Figure 5.1 (b): Temperature entropy diagram for a Gas Turbine Cycle</b>	- 80
<b>Figure 5.2(a): Schematic Drawing of a Simple Superheat Steam Turbine Plant</b>	- 87
<b>Figure 5.2(b): Temperature entropy Diagram of a Steam Turbine Cycle</b>	- 87
<b>Figure 5.3: Schematic Drawing of a Simple Hydro-Turbine Electricity Generating Plant</b>	- 91
<b>Figure 5.4: Schematic Drawing of the Nigeria Grid System</b>	- 97

















































































































































