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The Case of Sustainable Management of Waste in Germany (and Bremen) and Practical Lessons for Nigeria (and Lagos)

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The Case of Sustainable Management of Waste in Germany (and Bremen) and Practical Lessons for Nigeria (and Lagos)

A Policy Report on Sustainable Waste Management Prepared By

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Contents

Abstract

This study investigates the progress of waste management policies in Nigeria and in Germany, with special emphasis on the conditions in the Lagos State of Nigeria and in the Country State of Bremen in Germany. Also, the move from waste management in the linear economic model to resource management in the circular economic model. While waste management in the linear economic model focusses on a distinct hierarchy of objectives, the resource management in the circular model incorporates the whole life cycle of objectives. Focus is on the country state of Lagos in Nigeria and on the country state of Bremen in Germany. Both country states have a great role as harbour and logistic towns, as industrial towns and as towns with scientific and technological infrastructure. The study compares the progress of waste management policies but reflects on the different structures of waste management in the two country states, being the result of specific economic sectors and factors. Factors such as the importance of formal and informal private enterprises, the role of public institutions and private actors in the waste management business, the role of public waste management policies, laws, plans and balance sheets play a role in the study; also, the role of new equipment and new communication technologies for the further development of the waste industry is considered. The study is based on relevant literature which is available for the two countries/states and on meetings/interviews with experts on waste management in the two countries/states. A major result is that Germany (and Bremen) and Nigeria (and Lagos) can cooperate in a mutually beneficial way on waste management – in policymaking and planning, on developing and selecting equipment and new technologies, on services provision and training, but also on guiding the transformation process towards a circular economy. Nigeria can learn from the German and European way of implementing coherent policies, while Germany and Europe can learn from Nigeria's way to solve problems which arise at the local level. The study brought to attention that the waste industry in Germany and Bremen is embedded in a complex web of directives, laws and regulations; this is a strict policy framework from the EU level downwards and to the EU level upwards. In Nigeria, there is no coherent waste governance system down from the federation, but at local and state levels there are some binding rules (of formal and/or informal origin). This quite different way of organizing waste management has consequences. For Nigeria this situation means that local informal producers, local informal organizations, and local informal waste

management actors play a great role. Important is it that informal actors in the waste management business are rediscovered as partners of public agencies, public firms and formal private firms. Informal sector firms can also be partners in the transformation from the waste management in the linear economy towards resource management within the circular economy. Informal enterprises can ably prepare end-of-life products for re-use or they can make them the basis for recycling and recovery. Privatization versus re-communalization is another issue of relevance for the waste industry as experiences in Lagos and in Bremen show. For Germany, the decision criterion should the ability to innovate for a circular economy; this should be the basic criterion for privatization versus re-communalization. In Nigeria, a larger role of informal enterprises in the waste industry can contribute to the circular economy. Such firms can redesign the products and can remanufacture them for low-income social groups; waste can then be reduced or even prevented. Waste prevention is an issue for both countries/country states/municipalities. Bremen as a country state and Bremen as a municipality can give new ideas to a deep cooperation in a waste management partnership with Nigeria. Lagos can be the first address for such a cooperation, although the population and industry size of Lagos State is so much greater.

Keywords: Waste management in Nigeria and Germany, in Lagos State and Bremen State; waste prevention, waste recycling, waste re-use, waste recovery, waste disposal; resource management; new waste management policies and resource management technologies; transformation from waste management in a linear economy to resource management within a circular economy

Zusammenfassung

In dieser Studie wird der Fortschritt bei der Entwicklung von Reformpolitiken für die Abfallwirtschaft in Deutschland und in Nigeria untersucht. Besondere Relevanz haben die Entwicklungen und Reformbestrebungen im Bundesstaat Lagos (Nigeria) und im Bundesland Bremen (Deutschland). Insbesondere geht es in dieser Studie um die notwendigen Schritte hin beim Übergang vom linearen Modell des Managements der Abfallwirtschaft zum kreislaufwirtschaftlichen Modell des Ressourcenmanagements. Während das Management der Abfallwirtschaft im linearen Modell von der klaren Hierarchie der fünf Ziele der Abfallwirtschaft bestimmt wird, geht es beim Ressourcenmanagement des kreislaufwirtschaftlichen Modells um die Ziele für die Anpassung und Steuerung des gesamten Lebenszyklus der Produkte und Produktionsaktivitäten. Auf den Bundesstaat Lagos und auf das Bundesland Bremen wird Bezug genommen, weil es Ähnlichkeiten in der Wirtschafts- und Sozialstruktur der beiden Bundesstaaten gibt. Beide Bundesstaaten haben bedeutende Hafen- und Logistiksektoren, sind wichtige Industrie- und Handelsstädte und verfügen über eine differenzierte Wissenschafts- und Technologieinfrastruktur (Universitäten, Hochschulen, Forschungs- und Technologiezentren). Während Lagos auch ein wichtiges Finanzzentrum für Nigeria und für ECOWAS darstellt, ist Bremen ein wichtiges Luft- und Raumfahrtzentrum für Deutschland und Europa. Die Studie vergleicht nicht nur die Entwicklungen und Reformbemühungen im Bereich der Abfallwirtschaft, sondern reflektiert auch die Auswirkungen der unterschiedlichen institutionellen Strukturen auf die Leistungsfähigkeit der Abfallwirtschaft in den beiden Bundesstaaten. Diese Unterschiede ergeben sich aus den spezifischen ökonomischen Entwicklungen und Sektoren und hängen stark von den Faktoren ab, die mit der Struktur der Beschäftigung zu tun haben. Zu erwähnen ist das unterschiedliche Gewicht von privaten und öffentlichen Wirtschaftssektoren, die unterschiedliche Bedeutung von formellen und informellen Wirtschaftsakteuren, aber vor allem auch die unterschiedliche Rolle von öffentlichen und private Akteuren in der Abfallwirtschaft der beiden Bundesstaaten. Die Rolle der öffentlichen Abfallwirtschaft ist in den beiden Bundesstaaten sehr unterschiedlich zu bewerten; dies gilt insbesondere für die Rolle der Abfallwirtschaftskonzepte, der Abfallwirtschaftspläne und der Gesetze für die Regulierung der Abfallwirtschaftsgesetze. Die vorliegenden Abfallbilanzen der beiden Bundesstaaten sind Ausdruck der strukturellen

Unterschiede, die zu sehen sind und in der Analyse auch freigelegt wurden. Auch auf die Bedeutung einer neuen abfallwirtschaftlichen Infrastruktur und Ausrüstung wie auch von modernen Informations- und Kommunikationstechnologien (IKT) für das Management der Abfallwirtschaft wird - am Beispiel der beiden Bundesstaaten - eingegangen. Es zeigt sich, dass technologische Innovationen in der Abfallwirtschaft wichtig sind, aber auch soziale Innovationen sind für ein modernes Management der Abfallwirtschaft in beiden Bundesstaaten wichtig.

Die Studie basiert auf dem Studium relevanter Literatur, die für Lagos und Bremen aktuell verfügbar ist, aber auch auf Interviews mit Funktionsträgern der Abfallwirtschaft in den beiden Bundesstaaten. Ein wichtiges Ergebnis der Studie ist, dass Deutschland (und Bremen) und Nigeria (und Lagos) bei der Reform des Managements in der Abfallwirtschaft eng kooperieren können, was vorteilhaft für beide Partner wäre. Es bietet sich eine Kooperation in den Bereichen der Politik- und Institutionenreform an, aber auch bei der Planung der weiteren Schritte beim Übergang in die Kreislaufwirtschaft des Managements der Abfallwirtschaft und der Ressourcen. Auch bei der Entwicklung und Auswahl neuer Technologien wie auch beim Technologietransfer bieten sich Kooperationen zwischen Unternehmen und öffentlichen Einrichtungen an. Bei der Gestaltung von Dienstleistungsangeboten und bei der Einrichtung von Ausbildungsprogrammen für die Abfallwirtschaft sind Kooperationen ebenfalls sinnvoll und erfolgversprechend; bei perspektivischen Programmen, die mit dem Übergang zu einer Kreislaufwirtschaft im Abfall- und Ressourcenbereich zu tun haben, ist ebenfalls eine Partnerschaft empfehlenswert. Nigeria kann lernen vom deutschen bzw. europäischen Weg der Implementierung kohärenter Politiken in der Abfallwirtschaft; Deutschland und Europa wiederum können von Nigerias Weg der Lösung von abfallwirtschaftlichen Problemen auf lokaler Ebene lernen. Beide Aspekte sind wichtig - das Lernen über komplexe Regulierungen beim Management in der Abfallwirtschaft und das Lernen, wie ausgehend von lokalen Herausforderungen Ad Hoc-Lösungen beim Management in der Abfallwirtschaft gefunden werden können. Die Studie zeigt, dass die Abfallwirtschaft in Deutschland (und in Bremen) in ein komplexes System von Direktiven, Gesetzen und Regulierungen eingebettet ist, also in ein System, das von der EU-Ebene bis zur lokalen Ebene der Stadt und Kommune reicht. Gleichzeitig wird deutlich, dass nicht nur von der EU-Ebene und von der Bundesebene Impulse auf die Abfallwirtschaft ausgehen, sondern auch von der lokalen

Ebene und der Ebene von den Bundesländern abfallwirtschaftliche Impulse bis zur EU-Ebene reichen. In Nigeria gibt es bisher kein kohärentes System des Managements der Abfallwirtschaft auf der Bundesebene (noch weniger auf der ECOWAS-Ebene der regionalen Integration), das auch die Städte und Gemeinden erreichen würde; es gibt aber auf der Ebene der Bundesstaaten und auf der Ebene der Städte und Gemeinden Regeln und Verfahrensweisen, wie die formellen und informellen Akteure der Abfallwirtschaft koordiniert werden können. Es gibt daher in den beiden Ländern sehr unterschiedliche Ansätze, wie das Management der Abfallwirtschaft von oben bzw. von unten ausgehend organisiert werden kann. Die abfallwirtschaftliche Governance kann aber in beiden Ländern deutlich verbessert werden. Die Studie gibt daher wichtige Hinweise für die Ausgestaltung einer abfallwirtschaftlichen Reformpolitik.

Im Gegensatz zu Deutschland ist die Abfallwirtschaft in Nigeria durch Aktivitäten informeller Akteure geprägt. Lokale informelle Produzenten, lokale informelle Organisationen und lokale informelle abfallwirtschaftliche Akteure spielen eine große Rolle. Die informellen Akteure sind bereits jetzt wichtige Partner im System des Managements der Abfallwirtschaft. Deren Rolle wird gerade wieder neu entdeckt; es geht nun darum, diese Akteure mit den öffentlichen Einrichtungen der Abfallwirtschaft, aber auch mit den öffentlichen und privaten Unternehmen im Sektor, besser zu vernetzen. Informell agierende Unternehmen der Abfallwirtschaft können in Nigeria wichtige Partner beim Übergang von der Abfallwirtschaft des linearen Modells zur Kreislaufwirtschaft des Ressourcenmanagements werden. Informelle Unternehmen des verarbeitenden Gewerbes und der Dienstleistungswirtschaft agieren in Nigeria mit großer handwerklicher Geschicklichkeit und mit wirtschaftlicher Kompetenz, etwa bei der Verlängerung der Nutzungszeit von nicht mehr funktionsfähigen Produkten, Maschinen, Teilen von Produkten und Autos/Fahrrädern/Booten bzw. Komponenten. Es werden Anpassungen vorgenommen, aber auch komplexe Neujustierungen der Produkte und Teile bis hin zur Funktionserweiterung der früheren Produkte. Die End-of-Life-Produkte können von den informellen Produzenten aber auch für die Wiedergewinnung von Rohstoffen (Recovery) und durch das Verwenden von Teilen bzw. Komponenten (Recycling) für andere Produkte genutzt werden. Diese Fähigkeiten sind für die Industrieentwicklung, die Ressourcen- und Umweltschonung und für die Beschäftigungsschaffung in Nigeria wichtig. Die

Entwicklungszusammenarbeit (auch von Bremen aus) kann durch Technologietransfers und durch Ausbildungsprogramme diese wichtige Komponente der Abfallwirtschaft unterstützen. Die Privatisierung bzw. die Re-Kommunalisierung der Abfallwirtschaft sind politische Vorgänge von hoher Aktualität für Deutschland und Nigeria, aber auch für Bremen und Lagos. In beiden Bundesstaaten gibt es wiederkehrende Diskussionen über die Vorteilhaftigkeit staatlicher bzw. privater Akteure beim Management der Abfallwirtschaft. Privatisierungen (wie in Lagos), aber auch Re-Kommunalisierungen (wie derzeit in Bremen) beeinflussen derzeit das Management der Abfallwirtschaft. Die Abfallwirtschaft in beiden Bundesstaaten wird durch vielfältige Ansprüche von Seiten der Gesellschaft, der Wirtschaft und der Politik bestimmt. In beiden Bundesstaaten zeigt sich ein komplexer Prozess, einen Ausgleich von Interessen zu finden, der einerseits zu Innovationen in der Abfallwirtschaft führt, andererseits aber den Kreislauf-Gedanken in der Abfallwirtschaft stärkt. Für die Abfallwirtschaft in Deutschland und auch in Nigeria ist es wichtig, Entscheidungskriterien für Privatisierungen bzw. Re-Kommunalisierungen festzulegen, die zu technischen und sozialen Innovationen für eine Transformation in die Kreislaufwirtschaft beitragen werden. Für Nigeria ist es wichtig, als Entscheidungskriterium zu formulieren, ob die Einbeziehung der informellen Akteure in die abfallwirtschaftliche Wertschöpfungskette vertieft werden kann. In Nigeria kann die informell agierende Abfallwirtschaft den Übergang zur Kreislaufwirtschaft positiv beeinflussen. Solche Unternehmen können Produkte nach ihrer ökonomischen Lebenszeit neu positionieren und verwerten, sogar nachhaltig reproduzieren, um diese dann für Bezieher niedriger Einkommen erschwinglich zu gestalten. Dadurch kann der Abfall reduziert werden bzw. Abfall sogar vermieden werden. Aber auch in Deutschland sind Produktanpassungen und Produktneukonzeptionierungen im Rahmen der Kreislaufwirtschaft möglich und erreichbar. Für Deutschland sind im Rahmen der Entscheidungskriterien für Privatisierungen bzw. Re-Kommunalisierungen soziale und technische Innovationen von herausragender Bedeutung, um die Ziele der Kreislaufwirtschaft möglichst schnell zu erreichen. Die Vermeidung von Abfall ist ein wichtiges Thema in beiden Ländern/Bundessstaaten.

Bremen kann als Bundesland und als Stadt dazu beitragen, die Kooperation mit Akteuren der Abfallwirtschaft in Nigeria (und in Lagos) zu stärken. Eine tiefere Kooperation ist möglich und vorteilhaft für beide Seiten, weil in Bremen kompetente private Unternehmen, erfahrene

öffentliche Behörden und international anerkannte Forschungs- und Technologiezentren existieren, die abfallwirtschaftliche Expertise einbringen und auch transferieren können. Dies ist möglich trotz der Struktur- und Größenunterschiede zwischen Bremen und Lagos. Die Bevölkerungszahl und die Industrieleistung von Lagos sind im Vergleich mit Bremen und im Vergleich zu den beiden Gesamtwirtschaften Nigeria und Deutschland ungleich größer.

Schlüsselwörter: Abfallentsorgung in Deutschland und Nigeria, in Bremen und in Lagos; Abfallentsorgung, Abfallvermeidung, Abfallrecycling, Müllaufbereitung, Abfallablagerung, Ressourcenmanagement, neue Politik der Abfallentsorgung und Technologien für das Ressourcenmanagement; Transformation von der Abfallentsorgung in der linearen Ökonomie zum Ressourcenmanagement in einer Kreislaufwirtschaft

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[1] See for further information on this important Nigerian company: http://www.fenog.com/

Development Management Germany-Nigeria: Improving and Adapting Waste Management Value Chains". Professor Reuben A. Alabi, Professor at the Department of Agricultural Economics of Ambrose Alli University, Ekpoma, Edo State, Nigeria and a former Alexander von Humboldt Research Fellow at IWIM, was the director of this research project for the years 2015-2018**.** Experiences with German value chains in waste management were analysed and used for recommending evidence-based reforms in Nigeria. A cooperation with German and Nigerian enterprises in the field of waste management is envisaged, and a cooperation between German and Nigerian universities and research institutes being active in the field should be considered as an opportunity. The Nigerian professor intends to organize workshops in Nigeria to report on the research results and on the policy recommendations. The Research Group on African Development Perspectives in Bremen, headed by Professor Karl Wohlmuth, supports the researches. It is proposed to publish a volume of the African Development Perspectives Yearbook on the theme of "Policies and Strategies Towards a Circular Economy in Africa", using also material from the research project.

List of Abbreviations

AbfVerbrG	Abfallverbringungsgesetz (Waste Shipment Act)
AfDB	African Development Bank
AfDBG	African Development Bank Group
AGRAPA	Arbeitsgemeinschaft Graphische Papiere
APP	Agriculture Promotion Policy (of Nigeria)
ARSCP	African Roundtable on Sustainable Consumption and Production
ASDR	Africa Sustainable Development Report
ASN	Abfallschlüsselnummer (waste code classification number)
ATA	Agricultural Transformation Agenda (of Nigeria)
AU	African Union
BattG	Batteries Law of Germany
BCC	Basel Convention Centre (to implement the Basel Convention on Transboundary Flows of Waste)
BCCC	Basel Convention Coordinating Centre
BDE	Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft e. V.
BiPRO	Beratungsgesellschaft für integrierte Problemlösungen
BMBF	Bundesministerium für Bildung und Forschung
BMU	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit/ Federal Ministry For The Environment, Nature Conservation and Nuclear Safety
BMUB	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit

BMWi	Bundesministerium für Wirtschaft und Energie
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung/Ministry of Economic Cooperation and Development
bvse	Bundesverband Sekundärrohstoffe und Entsorgung e. V.
C&D	construction and demolition (waste)
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CEP	Circular Economy Package (of the EU)
CFSSD-6	Sixth Session of the Committee on Food Security and Sustainability Development
CLI	Cleaner Lagos Initiative
CSR	Corporate Social Responsibility
CWG	Collaborative Working Group (on Solid Waste Management in Low- and Middle- Income Countries)
CWG-WASH	CWG (Watertechnology DE)-Water, Sanitation and Hygiene
CWO	Commercial Wastes Ordinance
CWRM	Communications in Waste & Resource Management
DBS	Die Bremer Stadtreinigung
EBB	Entsorgungsbetriebe Bremerhaven
EC	Commission of the European Communities (Economic Commission)
ECA	Economic Commission for Africa
ECOFI	European Consortium of the Organic Based Fertilizer Industry
ECOWAS	Economic Community of West African States
EEA	European Environment Agency
EECA	Eastern Europe Central Asia (focus)

EEE	Electric and Electronic Equipment
EEG	Erneuerbare-Energien-Gesetz (Renewable Energy Sources Law)
EGSS	Environmental Goods and Services Sector
EGSSAA	Environmental Guidelines for Small Scale Activities in Africa
EJA	Environmental Justice Atlas
EKO	Entsorgung Kommunal (public municipal waste company in Bremen)
EMPA	Eidgenössische Materialprüfungs- und Forschungsanstalt/Swiss Federal Laboratories for Materials Science and Technology
ENCAP	Environmentally Sound Design And Management Capacity Building For Partners And Programs In Africa
ElektroG	Elektro- und Elektronikgeräte-Gesetz (Electric and Electronic Equipment Law of Germany)
ELVs	End of Life Vehicles
EPA	Environmental Protection Agency (of USA)
EPR	Extended Producer Responsibility
EPRS	European Parliamentary Research Service
ERPIS	European Recovered Paper Information System
ETC/SCP	European Topic Centre on Sustainable Consumption and Production
	EU European Union
EUBD	European Union Battery Directive
EWAP	E-Waste Africa Project
EWWR	European Week for Waste Reduction
EXNORA	EXcellent, NOvel and Radical (Indian Environment NGO)
FAO	Food and Agriculture Organization

FBRA	Food and Beverage Recycling Alliance (in Nigeria)
FCT	Federal Capital Territory (of Abuja)
FES	Friedrich-Ebert-Stiftung
FEPA	Federal Environmental Protection Agency (of Nigeria)
FME	Federal Ministry of the Environment (of Germany)
FSO	Federal Statistical Office (of Germany)
GewAbfV	Gewerbeabfallverordnung
GDP	Gross Domestic Product
GGKP	Green Growth Knowledge Platform
GHG	greenhouse gases
GesPaRec	Gesellschaft für Papier-Recycling
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GRP	Gross Regional Product (GDP for a region)
GTAI	Germany Trade & Invest
HBSN	Heinrich Böll Stiftung Nigeria
IBRD	International Bank for Reconstruction and Development (World Bank Group)
ICONSEET	International Conference of Science, Engineering & Environmental Technology
ICWME	International Conference on Waste Management and Environment,
ICT	Information and Communication Technologies
IDS	Institute of Development Studies
IETC	International Environmental Technology Centre

IconSWM	International Conference on Solid Waste Management
IJAET	International Journal of Advances in Engineering & Technology
IKT	Informations- und Kommunikationstechnologien
ILA	International Lead Association
ILO	International Labour Organisation
IOSR Journals	International Organization of Scientific Research Journals
IPW	Industrial Park Walsrode
IST	Instituto Superior Tecnico
ISWA	International Solid Waste Association
IT	information technology
ISWM	Integrated Sustainable Waste Management
ITC	International Trade Centre (Geneva)
IWIM	Institute for World Economics and International Management (University of Bremen, Germany)
IWM	Integrated Waste Management
IWM	Informal waste management
JMTM	Journal of Manufacturing Technology Management
KfW	Kreditanstalt für Wiederaufbau
Kg	Kilogramm
KrWG	Kreislaufwirtschaftsgesetz/Circular Economy Waste Management Act
LAWMA	Lagos State Waste Management Authority
LCA	Life Cycle Analysis
LCI	Life Cycle Inventory (approaches)

LG	Local Government
LGAs	Local Government Areas
LGCs	Local Government Councils
LSRDB	Lagos State Refuse Disposal Board
LSWDB	Lagos State Waste Disposal Board
MAW	Municipal and Agricultural Waste
MDGs	Millennium Development Goals
MEPP	Ministry of the Environment and Physical Planning
MoU	Memorandum of Understanding
MSW	Municipal Solid Waste
MWh	Megawattstunde
MWT	Ministry of Works and Transport
NAP	New Agricultural Policy (of Nigeria)
n. d.	no date
NASRDA	National Space Research and Development Agency (of Nigeria)
NCS	Nigeria Customs Service
NEMA	National Emergency Management Agency (of Nigeria)
NESREA	National Environmental Standards and Regulations Enforcement Agency (of Nigeria)
NEST	Nigerian Environmental Study and Action Team
NGO	non-governmental organisation
NPRP	National Plastic Recycling Programme (in Nigeria)
OECD	Organization for Economic Cooperation and Development

ORWA	West Africa Regional) Department of the African Development Bank, Abidjan/Tunis
PAYT	pay-as-you-throw (systems for municipal waste)
PET	Polyethylenterephthalat
PETI	Petitions (Committee of the European Parliament)
PMC	Pune Municipal Corporation
PPIAF	Public-Private Infrastructure Advisory Facility (for the Oyo State Government)
ProgRess II	Deutsches Ressourceneffizienzprogramm II
PRS	producer responsibility system
PSP	Private Sector Participation (in Nigeria's waste management policy)
PUMAU	Public Utilities Monitoring and Assurance Unit (in Lagos, Nigeria)
3R	Reduce, Reuse, Recycle
6R	reduce, remanufacture, reuse, recover, recycle, redesign).
REDIN	Recycling and Economic Development Initiative of Nigeria
RETech	German Recycling Technology Partnership
RoHS	Restriction of the use of Hazardous Substances (of EU)
RRR	Resources Recovery and Re-use
QMAP	Qualitätsmanagement Altpapier
SBC	Secretariat of the Basel Convention
SCYCLE	Sustainable Cycles (programme of the UNU/United Nations University in Bonn)
SDGs	Sustainable Development Goals
SDRA	Sustainable Development Reports on Africa (by UNECA)

SEET	School of Engineering & Engineering Technology (of The Federal University of Technology, Akure, Nigeria)
STOA	Panel for the Future of Science and Technology/Scientific Foresight Unit, European Parliament
SWaCH	solid waste collection and handling
SWB	Stadtwerke Bremen
TASi	Technische Anleitung Siedlungsabfall
TETFund	Tertiary Education Trust Fund
TOC	total organic carbon
TV	Television
UBA	Umweltbundesamt/Federal Environment Office (of Germany)
UEEE	Electrical and Electronic Equipment
UK	United Kingdom
ULAB	Used Lead Acid Batteries
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UN-ECOSOC	United Nations-Economic And Social Council
UN-HABITAT	United Nations Human Settlements Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNIDO	United Nations Industrial Development Organization

UNU	United Nations University
USAID	United States Agency for International Development
USD	US Dollars
VAK	Verband der Arbeitsgeräte- und Kommunalfahrzeugindustrie e.V.
VDMA	Verband Deutscher Maschinen- und Anlagenbau e. V.
VKU	Verband Kommunaler Unternehmen
VRU	Vehicle Recovery Unit
WAMASON	Waste Management Society of Nigeria
WEEE	Waste Electrical and Electronic Equipment (Act of EU)
WFD	Waste Framework Directive (of EU)
WMA	waste management act
WMP	Waste Management Plan
WPP	Waste Prevention Programme
WSA	Waste Shipment Act
WSSD+5	World Summit on Sustainable Development Outcomes in Africa
WSR	Waste Shipment Regulation
WPP	Waste Prevention Programme (of Germany)
ZEF	Zentrum für Entwicklungsforschung, Universität Bonn/Centre for Development Research, University of Bonn

Executive Summary

In twelve sections waste management policies are compared for Germany and Nigeria, with a focus on the country states of Bremen and Lagos. Section 1.0 sets the frame, arguing that a comparative study can be useful for both countries and for both country states. Such a comparative study can support innovative ideas how to manage waste in urban and rural areas of the two countries. Such a comparative view can also help in transferring technologies and business models for waste management. Also, the research design is presented, based on literature surveys and interviews with key decisionmakers. In section 2.0 an overview on The Waste Management Problems of Nigeria is presented. It is interesting to note that Nigeria's waste industry is to a large extent informally organized, but also formal industry elements play a role. The specific combination of formal and informal industry components along the waste management value chain is analysed. This mixture off elements has to do with the heterogenous socio-economic structure. Lagos State is composed of various sub-urban areas, and these can be ranked by income levels and by availability of basic infrastructure. Richer areas can pay for excellent private services of waste management, but poorer areas depend on ´traditional/informal waste management services and some public centres where waste is collected prior to recycling and disposal. So, the number of stakeholders in the waste industry business is rather large. Also, the heterogenous structures lead to quite different technologies and business models. Section 3.0 gives information on the Role of the Informal Private Sector in the Waste Management System of Nigeria. The activities of the informal sector in the waste industry are wide – they range from collection of waste door-to-door to recycling, recovery and disposal. Also, equipment for waste management is produced, and various informal services are provided, such as collection of fees, handling of fills and dumps, and transport and support services. To some extent, also associations of informal entrepreneurs and workers play a role. These associations are more important in other developing countries, and so there is room for strengthening them. Section 4.0 is presenting the Role of the Formal Waste Management System in Nigeria. Lagos State is an example of a country state and municipality equipped with a system of formal waste management since decades. The history of waste management of Lagos shows that institutional adaptations were continually on the agenda – to focus on new policies, new regulations, and new

performance levels. The hierarchy of waste management objectives was in mind – moving up from waste disposal to waste recovery, to waste recycling and ultimately to waste prevention. Also, measurement of performance played an increasing role. However, the results are commented critically as well as the ambitions to privatize or to re-communalize the waste management system. Section 5.0 gives a discussion on the Challenges to the Formal Waste Management System in Nigeria. There are important challenges discussed in the study. The integration of formal and informal waste management systems is still unsolved. The issue of privatization versus re-communalization is discussed widely, and so far, there is no definite solution. The way up in the hierarchy of waste management objectives from dumps and landfills to recovery, recycling and waste prevention is quite different from area to area. The waste management problems of municipalities need to be considered with the waste management problems of the surrounding rural and semi-urban areas. And, institutional and technological issues need more consideration. In section 6.0 the Relevance of Integrated Sustainable Waste Management (ISWM) Systems is highlighted for Nigeria. Models of Integrated Sustainable Waste Management (ISWM) Systems play a role in the international discussion and developing countries will benefit from the discussion. Various approaches are discussed, and it is shown that Nigeria is already an important partner of the international discussions. Because of the huge size of the population, the increasing urbanization and the rising economic importance of the country waste management is a key factor to provide a healthy environment and to secure sustainable improvements of livelihoods. In Section 7.0 an overview of Applying the Concept of an Integrated Sustainable Waste Management (ISWM) System in Nigeria is presented. It is argued that countries like Nigeria need to follow the standard recommendations on the hierarchy of waste management objectives, but it is necessary to consider a quite different time path. Although waste prevention is becoming also important for Nigeria, the country should first focus on immediate concerns, such as providing for appropriate sanitary conditions in landfills and for a higher recycling rate of organic waste for composing. Intermediary steps play a great role in the ISWM System for Nigeria. Also, appropriate technological developments matter, by using the local competences which are available in the informal sector establishments in the country. Related training and global cooperation initiatives are also a priority.

The following sections focus on Germany and on the country state of Bremen in order to find out what Nigeria and the country state of Lagos can learn from a country and a country state with advanced waste management systems. As Germany is a member of the European Union (EU) while Nigeria is a member of ECOWAS, the regional integration is also seen as a vital part of effective waste management policies. Section 8.0 gives details on Waste Generation and Waste Management in Germany: Structures, Trends, Strategies and Policies (With Implications for Waste Management Reforms in Nigeria). The implications of waste management policies of Germany for Waste Management Reforms in Nigeria are outlined in a detailed way in the study, by referring to ten key issues which are prominently discussed in the German reform policy on selected issues of waste management. For all the ten key issues it is argued that Nigeria and the State of Lagos can benefit from the Germany-focussed solutions and the Bremen-specific experiences. Sub-section 8.1 is on Waste Prevention in Germany. There is some progress with waste prevention in Germany, but much more needs to be done. Lessons for Nigeria are presented. It is emphasized that awareness among the urban people and among the small farmers is key to prevent uncontrollable amounts of waste in Nigeria. Sub-section 8.2 on Recovery and Disposal of Waste in Germany records the progress achieved, but also the challenges ahead. There are some lessons for Nigeria, especially to have focussed and coherent policies on recovery. Also, the data situation is relevant. While Germany is embedded into the EU waste reporting system, Nigeria's federal government is not guiding the states and the FCT of Abuja. Sub-section 8.3 on Commercial Waste in Germany gives indications that there are weaknesses of the German system to deal with commercial waste. Therefore, Nigeria cannot learn too much from the German system, but needs to go along own paths of handling this issue. The growth of commercial waste in Nigeria has to do with industrial development and growth of supermarkets in the country, but the huge urban and rural markets need a much better waste management. Sub-section 8.4 on Waste Graphic Paper and Packaging Waste in Germany holds lessons for Nigeria. Still newspapers and printing materials are relevant in the context of waste volumes in Nigeria; also packaging materials are starting to become a major problem in urban areas. Regrettably, the waste management authorities of Nigeria have not identified the trends and the dangers inherent in the spectacular growth of these volumes. Again, the role of EU waste management policies for Germany needs to be emphasized; such a guiding role is not present in Nigeria. Sub-section 8.5

is on Bio-waste, Marketing of Compost and Digestate and Sewage Sludge in Germany. This category of waste is organized in an effective way in Germany, and because of the importance of organic waste in Nigeria the solutions found in Germany and in other EU countries have relevance for Nigeria. A better link of urban waste management authorities with agribusinesses in rural areas can help to control the organic waste problem. Sub-section 8.6 on Waste from Electrical and Electronic Equipment, Waste Batteries, and treating all forms of E-Waste in Germany is of increasing relevance for waste management. Nigeria is starting to work on these problems, and the informal sector in the country has interest to provide solutions. However, there are great health problems involved because of the unawareness of informal workers about the inherent dangers. Training directly in the informal establishments may be a solution. Sub-section 8.7 on Managing the Problem of End of Life Vehicles in Germany again shows how important the guiding role of the EU is. There are some lessons for Nigeria, and the authorities in Lagos seem to react timely to the challenges. Separate units care for such vehicles, but it is not enough to have some pilot projects. Regular removal and waste management activities are requested. Sub-section 8.8 on Management of Mineral Waste in Germany shows that even Germany is far away from a circular economy in this field. For Nigeria, this segment is very important as the construction industry is to a large extent beyond any control by waste management authorities. Some regulations borrowed from the EU and some pilot projects initiated by donors present some interesting models of coping with these types of waste. Sub-section 8.9 on Waste Exportation and Importation Practices and Policies of Germany is of high relevance for Nigeria. Although there are some problems in Germany to control these flows of exports and imports, the problems in Nigeria and for West Africa are incomparably greater. Customs authorities and control agencies between states are insufficiently equipped to identify such flows. Again, Basel Convention Coordination Centres (BCCC) and other global and regional institutions help to control such forms of foreign trade, but the drivers of such are not too often identified. Sub-section 8.10 is on Avoiding dangerous environmental and health impacts through waste management in Germany. It is shown that Germany needs much more to do in this direction, but the country nonetheless can at this stage export expertise to countries like Nigeria. As Nigeria has a great number of qualified scientists in these fields, getting them involved in global and regional scientific networks may be the best investment from the side of Germany and the EU.

The cooperation of waste management authorities with such networks of scientists is relevant for Germany and for Nigeria. Bremen has a lot to offer in this respect because of its scientific infrastructure.

Section 9.0 presents a discussion on Waste Generation and Waste Management in the Country State and the Municipality of Bremen, Germany – Innovative Approaches. Emphasis is on innovative approaches to handle the waste management issues in an intermediary-sized municipality. Such innovations are related to the whole waste management value chain, starting from the concept of waste to the operationalization of waste management. Reporting on waste volumes and types of waste is of importance, as the various types of waste need the application of quite different waste management strategies. And, the trends with regard of these types of waste are changing because of structural changes impacting through drivers of production and consumption behaviour. It is so that better data are needed for waste management, and that early reflections on adapting regulations depend on better information about trends. The case of Bremen municipality also shows that waste management fees play a significant role for any improvement of performance. The structure of fees is important for providing incentives to households, commerce, industrial firms, and other responsible units which are producing waste. The form of cooperation between public and private actors in waste management is also of great importance for successful models of waste prevention and waste reduction. Such a stakeholder and public-private partnership approach is easier to undertake in the country state of Bremen because of its small size. In Section 10.0 follows a presentation of The German Waste Management System in the European Union (EU): The Comparative Ranking of the German Waste Management System and Consequences for Reforms. This section again shows that EU-wide rankings of the waste management performance matter for reforms in individual countries. Each EU country can benefit from the best performer related to 18 criteria for five categories of waste management performance. Nigeria lacks such a system among its 36 states plus the FCT of Abuja. The case of Germany shows that the data production infrastructure provided by the Federal Statistical Office (FSO), the Federal Ministry for the Environment (FME) and by the Statistical Services of the EU itself make possible peer reviews among the 28 (after Brexit 27) EU countries. Section 11.0 is bringing together the theme Towards an Integrated Sustainable

Waste Management (ISWM) System: Practical Lessons for Nigeria from the German Waste Management System. Obviously, many lessons can be derived from the German (Bremen) model being of relevance for Nigeria (Lagos). The lessons belong to all steps, interactions and links of the waste management value chain. But the study also shows that adaptations are needed in Nigeria as in many cases simpler and indigenous solutions are needed because of the lack of data, the lack of concepts, the lack of institutions, the lack of personnel, and the lack of public and individual awareness. Regrettably, too often donors in the field of the waste industry have tried to impose well engineered technical solutions (complex recycling installations, complex waste industry equipment, complex IT hardware and software, complex logistical solutions, and complex regulations), without reflecting on the barriers of hard and soft infrastructure. Finally, Section 12.0 gives Conclusions. The Conclusions again emphasize that Nigeria and Germany can mutually benefit from cooperation and exchanges about waste management strategies, policies and authorities. Although Germany has made significant progress on the way to a circular economy, the real situation is that the gaps on this path are still severe. Nigeria also emphasizes a circular economy approach but has yet to reach a simple version of the linear economic model with small steps towards recovery, recycling, reduction and prevention in waste management.

This study investigates the progress of waste management policies in Nigeria and in Germany, with special emphasis on the conditions in the Lagos State of Nigeria and in the Country State of Bremen in Germany. Also, the move from waste management in the linear economic model to resource management in the circular economic model is still ahead in both countries, although Germany is more advanced on these issues. While waste management in the linear economic model focusses on a distinct hierarchy of waste management objectives, waste and resource management in the circular economic model incorporate the whole life cycle of traditional and newly designed products and services in regard of the stated waste and resource management objectives. Focus is in the study on the country state of Lagos in Nigeria and on the country state of Bremen in Germany. Both country states have a great economic role as harbour and logistic towns, as industrial towns and services hubs, and as towns with a huge scientific and technological infrastructure. The study compares the progress of waste management policies but reflects also on the different structures of waste management in the two country states, being the

result of specific economic sectors and determining factors. Factors such as the importance of formal and informal private enterprises, the role of public institutions and private actors in the waste management business, the impact of public waste management policies, laws, plans and balance sheets play a role in the study; also, the importance of new equipment and of new communication technologies for the further development of the waste industry is considered. The study is based on relevant literature which is available for the two countries/states and on meetings/interviews with experts on waste management in the two countries/states.

A major result is that Germany (and Bremen) and Nigeria (and Lagos) can cooperate in a mutually beneficial way on waste management – in policymaking and planning, on developing and selecting equipment and new technologies, on services provision and training, but also on guiding the transformation process towards a circular economy. Nigeria can learn from the German and European way of implementing coherent policies, while Germany and Europe can learn from Nigeria's way to solve waste management problems which arise at the local level. The study brought to attention that the waste industry in Germany and Bremen is embedded in a complex web of directives, laws and regulations; this is a strict and coherent policy framework from the EU level downwards and to the EU level upwards. In Nigeria, there is no coherent waste governance system down from the federation, but at local and state levels there are some binding rules (of formal and/or informal origin) on stakeholders/actors. This quite different way of organizing waste management has consequences. For Nigeria, this situation means that local informal producers, local informal organizations, and local informal waste management actors play a great role. Important is it that informal actors in the waste management business are rediscovered as partners of public agencies, public firms and formal sector private firms. Informal sector firms can also be partners in the transformation from the waste management business in the linear economy model towards waste and resource management in the circular economy model. Informal enterprises can play a vital role in this transformation; they can ably prepare end-of-life products for re-use or they can make them the basis for recycling and recovery. Privatization versus re-communalization of waste management is another issue of relevance for the waste industry as current experiences in Lagos and in Bremen show. For Germany, the decision criterion should be the ability to innovate for the transformation towards a

circular economy; this should be the basic criterion for the decision of privatization versus re-communalization in waste management. In Nigeria, a larger role of informal enterprises in the industry can contribute to the circular economy. Such firms can redesign the products and can remanufacture them for low-income social groups; waste can then be reduced or even prevented. Therefore, rediscovering the role of informal enterprises is a great opportunity for the nation. Waste prevention is an issue for both countries/country states/municipalities. Bremen as a country state and Bremen as a municipality can give new ideas and concrete plans to form a deep cooperation in a waste management partnership with Nigeria. Lagos can be the first address for such a cooperation with Bremen, although the population size and the industry size of Lagos State are so much greater.

The Case of Sustainable Management of Waste in Germany (and Bremen) and Practical Lessons for Nigeria (and Lagos)

1.0 Introduction

The amount of waste generated in either developed or developing countries depends on the population, the degree of urbanization and industrialization, and the intensity of agricultural activities in such a nation (UNESCAP, 1993). According to World Bank statistics (The World Bank, 1999), it was estimated that in Asia high income countries generate more municipal waste than low- or middle-income countries. For example, High-income countries (such as Australia, Japan, Hong Kong, China, Republic of Korea, and Singapore) produce between 1.1 and 5.0 kg/capita/day; middle-income countries (such as Indonesia, Malaysia and Thailand) generate between 0.52 and 1.0 kg/capita/day, whilst low-income countries (such as Bangladesh, India, Viet Nam and Myanmar) have generation rates of between 0.45 and 0.89 kg/capita/day. In addition, Asian and Pacific Regions are said to be currently producing about 1.5 million tons of Municipal Solid Waste (MSW)[2] each day and these are expected to be double by 2025 (World Bank, 1999). More recent information (The World Bank 2012, World Bank Group 2018b) reveals that there is a danger of a "waste explosion" developing parallel to the global urbanization trends; speed of waste generation is exceeding the speed of urbanization trends despite of many warnings about such a situation since a long time.[3]

While in 2002 2.9 billion urban residents have generated about 0.64 kg of MSW per person per day (0.68 billion tonnes per year), in 2012 the figures are 3 billion urban residents generating 1.2 kg per person per day (1.3 billion tonnes per year). For 2012, 4.3 billion urban residents were generating 1.42 kg/capita/day (2.2 billion tonnes per year). These figures (from The World Bank 2012) are updated (in World Bank Group 2018b), showing the danger of a "waste explosion" up

[2] See on the MSW concept and the observed trends in different areas: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/municipal-solid-waste

[3] See on the major tendencies and facts of global waste: https://www.sciencedirect.com/topics/earth-and-planetary-sciences/municipal-solid-waste and https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report

to 2050 if not politically attacked in a few-years-time. It is emphasized (World Bank Group 2018b) that global waste generation will jump to 3.4 billion tonnes over the next 30 years, up from 2.01 billion tonnes in 2016. By 2050, waste generation in Sub-Saharan Africa (SSA) is expected to more than triple from current levels. Although plastics has only a share of 12% of global solid waste, the environmental consequences are huge because of impacts on waterways and ecosystems. And, only 4% of the solid waste is recycled in low-income countries, while the share recovered (recycled and composted) is more than one-third in high-income countries. Treatment of waste has also an impact on climate change as the carbon-dioxide-equivalent is 1.6 billion tonnes and reaches 5% of global emissions. New technologies are not only needed for collection and transport, but also for waste disposal and management. Digital technologies and digital education systems may be useful tools and systems in this context.

Similarly, in Africa thousands of tonnes of waste are generated daily which are approximately 0.5 kilograms per person per day and in some cases the volumes are reaching as high as 0.8 kilograms per person per day.[4] Although most of the waste is biodegradable, based on peoples' consumption, for health reasons higher collection and disposal rates are urgently requested (see: Bello, Ibrahim Adebayo, Muhamad Norshafiq bin Ismail and Nassereldeen A Kabbashi 2016). And, new types of waste (e-waste) is creating new problems (for the environment) and new opportunities (for service industries). While the African waste figures may seem modest compared to the 1–2 kg per person per day volumes which are generated in developed countries, most of the waste in Africa is not collected by municipal collection systems because of poor management, fiscal irresponsibility or malfeasance, equipment failure, or inadequate waste

[4] In a review article from May 2016 by Ibrahim Adebayo Bello, Muhamad Norshafiq bin Ismail and Nassereldeen A Kabbashi the composition of solid waste in Africa is presented; see: https://www.omicsonline.org/open-access/solid-waste-management-in-africa-a-review-2252-5211-1000216.php?aid=73453. The figures on volumes for cities in Africa show that waste generation in between 0.4 kg per capita per day in Dar es Salaam to 0.59 in Kampala and 0.6 in Nairobi. The share of bio-waste is large – 71% in Dar es Salaam, 77.2 % in Kampala and 65% in Nairobi. But the data are back from 2006/2007, and so it is a problem to assess the waste explosion of the recent decade. Especially the e-waste through electronic gadgets has come up in these years. Figures for the waste collection show that not more than 40% of the waste is collected in Dar es Salaam, but 60% in Kampala and 65% in Nairobi. Beside of bio-waste paper, plastic, glass, metal, and others are relevant. It is important to consider that the composition of waste differs considerably between large cities. But there is no data base for small and intermediate cities, and for rural areas.

management budgets (USAID/EGSSAA, 2009).[5] MSW capacity building is urgent in Africa, but also a cooperation with local environmental protection capacities.

Nigeria is located at the Western part of Africa. It has 36 States and a Federal Capital Territory (FCT). The World Bank report of 2011 (World Bank, World Bank Data[6]) stated the population of Nigeria as 190,886,311. The Gross Domestic Product (GDP) in Nigeria was worth 376 billion US dollars in 2017, although there are wide annual variations[7] Data for 2014, 2015 and 2016 show a GDP at billion US dollars 547, 487 and 405, with low estimates and forecasts provided for 2017 and 2018.[8] GDP in Nigeria averaged 70.94 USD billion for the period from 1960 to 2013, reaching an all-time high of 523 USD billion in 2013 and a record low of 4.20 USD billion in 1960.[9] Nigeria suffers from slow growth, and this impacts on poverty[10]. Real GDP growth was negative at -1.6% in 2016; and for 2017 the estimates are at 0.9%. The increase in the GDP (although small in recent years), which is one of the indicators of the standard of living, implies nonetheless a sharp increase in waste generation in Nigeria. Mismanagement of waste along the whole value chain from production to transport and marketing and to consumption and recycling is a key factor determining the expansion of waste generated. The problems of waste management are also increasing because of changing consumption patterns, because of increasing transport and industrial development, and because of urbanization. According to

[5] A new project by USAID has replaced the ENCAP Africa programme (ENCAP/Environmentally Sound Design And Management Capacity Building For Partners And Programs In Africa), which has published the Environmental Guidelines for Small Scale Activities in Africa (EGSSAA). The new programme (GEMS/Global Environmental Management Support) is strong in capacity building and has a database on environmental compliance; see: http://www.usaidgems.org/.

[6] Source of annual data: https://data.worldbank.org/country/nigeria

[7] See on the GDP development after re-basing the value of GDP from 1990 to 2008: AfDBG/African Development Bank Group, January 2013, p. 2

[8] See the World Bank Update on Nigeria: World Bank Group, 2018a, April 2018; access: http://documents.worldbank.org/curated/en/769551524576691390/Nigeria-biannual-economic-update-connecting-to-compete

[9] See on these historical GDP data: https://tradingeconomics.com/nigeria/gdp-per-capita. Data for GDP per capita are indicated in this source also; the Gross Domestic Product per capita in Nigeria was last recorded at 2,412.41 US dollars in 2017. The GDP per capita in Nigeria is equivalent to 19 percent of the world's average. GDP per capita in Nigeria averaged 1,661.41 USD from 1960 until 2017, reaching an all-time high of 2,563.10 USD in 2014 and a record low of 1089.10 USD in 1968. GDP per capita (PPP) is much higher, reaching 5,338. 45 USD.

[10] See the Country Note Nigeria, 2018 African Economic Outlook, OECD/AfDB/UNDP Project; Access: https://www.afdb.org/en/knowledge/publications/african-economic-outlook/country-notes/

BioEnergy Consult, July 2018[11], Nigeria generates more than 32 million tons of solid waste annually, out of which only 20-30% is collected. There are wide differences in the solid waste generation rate; it was found to vary from 0.13 kg/capita/day in Ogbomosho to 0.71 kg/capita/day in Ado-Ekiti.[12] Case studies for cities (such as Nwachukwu, Maxwell Umunna, 2010) show that without major reforms the generation of waste will outpace more and more the disposal capacity for the waste. Population increase is only one factor determining the relation between generation and disposal of waste.

In Nigeria, however, the waste management systems which are in use are still inadequate, unsustainable and unable to cope with the most ever-increasing volume of waste being generated day by day. And, the systems are highly informal, and there are strong barriers to integrate these systems into formal ones (see: O. O. Oguntoyinbo, 2012). While the informal systems have important environmental and socio-economic roles, the barriers are many to make them part of formal systems: repressive policies, unhygienic waste collection methods, lack of policy and operative support, and lack of access to equipment, skilled staff and facilities for the processing of waste. With the increase in population, the ongoing urbanization, the spread of informal sector activities, the industrialization processes lacking standards and regulations, and with impacts such as from globalization (on consumption styles, on marketing channels, on social stratification, on trade and spread of new e-technologies), the challenge of waste management in Nigeria has increased and is even becoming now more complex. Nigeria has a share of more than 35% of the population living in cities, with an urbanization growth rate of about 7% per annum; less than 10% of the city populations enjoy any waste management services (Ossai, 2006). The rate of waste generation in Nigeria is on the increase, with an estimated rate of growth of 0.4 to 0.8 tonnes/capita/annum (Iriruaga, 2012). Iriruaga (2012) has indicated that in Lagos State, for instance, total waste generation is estimated at 9,000 tonnes per day, while in Kano it is estimated at 3,849 tonnes per day. Therefore, it is common practice to dispose-off the rubbish in unsafe landfills and illegal dumps, or to dump it directly in rivers and sewers.

[11] See on the data and the trends on MSW for Nigeria: https://www.bioenergyconsult.com/solid-waste-nigeria/
[12] See on these data: https://www.emeraldinsight.com/doi/pdfplus/10.1108/MEQ-08-2013-0092

Local authorities are often unable to introduce integrated waste management systems due to the associated high costs, but also due to lack of knowledge and expertise. The waste management systems are fragmented, and participation of the people, of the civil society and of the local and the state government levels in policy-formulation and in law-making is not practised.[13] There is also a lack of operational waste management models that are capable of financing themselves while operating effectively in Nigeria. It is in the light of this that we have examined the waste management system in Germany, with a specific focus on the Country State of Bremen. We have done this with the intention to assess what Nigeria can learn from Germany's effective and efficient waste management system. The system of waste management in Germany is of interest as some innovative features are observable and some of these are relevant for reforming the system in Nigeria. Therefore, the aim of this paper is to benchmark the German waste management system as a successful example for Nigeria in order to establish a sustainable and effective waste management system in Nigeria. Because of the importance of Nigeria for global sustainable development the case study is highly relevant.[14] The focus on the Country State of Bremen has also to do with the leading role of the Green Movement in this country state.

In section 2.0 we present an overview on The Waste Management Problems of Nigeria. Section 3.0 gives information on the Role of the Informal Private Sector in the Waste Management System of Nigeria. Section 4.0 is presenting the Role of the Formal Waste Management System in Nigeria. Section 5.0 gives a discussion on the Challenges to the Formal Waste Management System in Nigeria. In section 6.0 we highlight the Relevance of Integrated Sustainable Waste Management (ISWM) Systems for Nigeria. In Section 7.0 we give an overview of Applying the Concept of an Integrated Sustainable Waste Management (ISWM) System in Nigeria. Section 8.0 gives details on Waste Generation and Waste Management in Germany: Structures, Trends,

[13] See a strong critique of the waste management system in Nigeria: Benefit Onu et al. 2012; access: https://www.researchgate.net/publication/287869869_Solid_waste_management_A_critique_of_Nigeria%27s_waste_management_policy

[14] The two major areas of environmental concern over the management and disposal of waste are first, the conservation of the resources and second, the pollution of the environment. There are two major concerns that need urgent attention for the survival of our future generation needs. These are first, the continuous increase in pollution and the waste that is overwhelming our planet and that cannot be absorbed or converted to harmless compounds and second, the accelerated decline of renewables such as water, soil, forests, fish stocks, and biodiversity (Opeyemi, 2012).

Strategies and Policies (With Implications for Waste Management Reforms in Nigeria). Section 9.0 presents a discussion on Waste Generation and Waste Management in the Country State and the Municipality of Bremen, Germany – Innovative Approaches. In Section 10.0 we present The German Waste Management System in the European Union (EU): The Comparative Ranking of the German Waste Management System and Consequences for Reforms. Section 11.0 is bringing together the theme Towards an Integrated Sustainable Waste Management (ISWM) System: Practical Lessons for Nigeria from the German Waste Management System. Finally, Section 12.0 gives Conclusions.

2.0 The Waste Management Problems of Nigeria

The problem of solid waste is a universal and major one as waste exists in every society. Waste management problems only appear more serious in developing countries because of the poor management framework (Ukpong and Udofia, 2011). The quantity and type of waste generated depends upon the function which a city performs, its economic status and the level of technological and industrial development. It makes a difference if the city is large, intermediate, or small, if it is surrounded by major agricultural production, if it is populated with informal manufacturing producers, if it has a strong middle class with a lot of relatively wealthy consumers, etc.[15] Initially, waste management efforts were directed merely at the removal of waste from the urban and peri-urban centres and the subsequent destruction of such waste. Later, attention shifted to waste utilization, waste reduction, re-use and re-cycling, management of hazardous substances, and the prevention of pollution emanating from waste disposal. In Nigeria, a major feature of the urban and semi-urban environment, particularly from the beginning of the oil boom in the 1970's, was the rapid takeover of cities by all kinds of waste. Most state capitals

[15] Case studies, such as for Port Harcourt in Nigeria, show how quickly a "garden city of Nigeria" can become a "garbage city of Nigeria", with negative effects on the quality of drinking water and on the health situation all over the city; see the essay by Ayotamuno/Gobo 2004; access: https://www.researchgate.net/publication/242022999_Municipal_Solid_Waste_Management_in_Port_Harcourt_Nigeria. The case study for the 13 Local Government Areas (LGAs) of Lagos State (Chidiebere et al. 2018) shows that the capacity to manage the waste which is generated and the number of recycling firms are not at all sufficient so that a new management framework is needed; see for access: https://www.researchgate.net/publication/325123237_MUNICIPAL_SOLID_WASTE_MANAGEMENT_IN_AFRICAN_CITIES_A_CASE_STUDY_OF_LAGOS_STATE_NIGERIA. The situation in Benin City may be even worse, when asking households about the waste collection system (Ogu 2000); the public waste management system but also the privatization scheme for waste collection of 1995 were not found adequate; see for access: https://journals.sagepub.com/doi/abs/10.1177/095624780001200209.

and other large cities are littered with huge volumes of waste despite the presence of state and local government-owned waste management agencies including private waste collectors[16]. The figure 1 below shows the 36 states of the Federal Republic of Nigeria, with Lagos State representing only a small geographical area, but being an entity with great economic and political importance.

Figure 1: The 36 States and 1 Federal Capital Territory of the Federal Republic of Nigeria

Source: Federal Government of Nigeria via Google

[16] Private waste collectors are either part of the formal system or of the informal system; an integration of both systems would be useful, as youth scavengers in the informal sector are unprotected. Scavengers play a great role in the waste collection, recycling and disposal system in Nigeria, so that the integration into a regulated system waste management system would be advantageous for all people; see on the role of scavenging the paper by Muktar (2010) for access: http://www.gamji.com/article8000/NEWS8771.htm. Scavengers can become fully integrated into the public waste management system. Their activities can reduce considerably the waste collection, recycling and disposal costs if the households are educated and trained to separate their waste systematically; see the study by J. C. Agunwamba, 2003: https://www.ncbi.nlm.nih.gov/pubmed/14703917.

No town in Nigeria, especially the urban and semi-urban centres of high population density, can boast of having found a lasting solution to the problem of filth and huge piles of solid waste. Rather, the problem continues to assume dangerous dimensions (Mba, 2003). According to the FEPA/Federal Environmental Protection Agency[17] (FEPA, 1992), about 20 kg of domestic waste was generated per capita per year in Nigeria in 1991. This has increased to more than 200 kg per capita per year in 2012 if we go by the fact that the average waste generated daily per capita in Nigeria was 0.55 kg. And, this refers now to the population of 160 million. The NEST/Nigerian Environmental Study and Action Team (NEST, 1991) reported that Nigeria generated over 60% of its waste as leaves and food waste in the 1960's. With the growth of industries in recent years, polythene and paper of various types have replaced leaves which are being used as wrapping and packing materials. [18]

The fact remains that the rate of collection and evacuation of waste is perpetually behind the rate of generation which makes waste accumulation a major source of environmental nuisance in Nigerian cities (Uwadiegwu and Chukwu, 2013). For example, Sada (1984) reported that in 1980, on the average, a balance of 100 metric tonnes of solid waste was piled up daily in Benin City, Nigeria. This was so because, while about 350 metric tons of solid waste were generated daily, the maximum rate of evacuation achievable was only 250 metric tons daily. Atuegbu (2007) has observed that 500 to 850 metric tons of waste were generated daily in Enugu city. Big cities like Abuja, Lagos, Port Harcourt, and Kano in Nigeria produced on the average 0.66kg, 0.63kg, 0.60kg and 0.56kg of waste per person per day respectively. Taking the population into account, this translates to about 105 tonnes, 5,058 tonnes, 632 tonnes and 1,819 tonnes of waste per capita per year in Abuja, Lagos, Port Harcourt, and Kano respectively (Iriruaga, 2012). As living standards rise, people consume more and generate more waste. The results indicated large rates of waste generation without a corresponding efficient technology in place to manage the waste. From available evidence out of examples, we see that only 35.8% used waste collection

[17] The National Environmental Standards and Regulations Enforcement Agency (NESREA) took over the functions of FEPA; access: http://www.nesrea.gov.ng/about-us/

[18] Nigeria has a high share of food waste among the various types of waste, but it has also a high share of overall food produced which is wasted, say 30-40%, worth at 750 billion US dollars (see on this percentage: https://www.thenigerianvoice.com/news/262345/nigeria-wastes-40-of-food-but-millions-of-citizens-are-dyin.html). So, Nigeria has millions of hungry and poor people, high imports of food, and at the same time enormous volumes of food which are wasted.

services, 64.2% used other waste disposal options, and 16.4% used both forms. From the households, 68.7% and 58.7% were aware of waste collection services and waste management regulations, respectively; while 28.4% separated their solid waste at source (Babayemi and Dauda, 2009). The private waste collectors' charge is between 500 and 1000 naira per drum.[19] Of the total solid waste generated in Nigeria, 66.1% are domestic, 20.3% are commercial, and 11.4% are industrial (Adewumi et al., 2005). This distribution means that the domestic sector of the private households is still dominant. Industrial development and the growth of the middle class may change the distribution over time, but all depends on the type of development (more inclusive, green and sustainable paths or to the contrary, rather unsustainable paths).[20]

A major disadvantage of improper disposal of waste, especially bio-waste, is that the organic carbon in the waste is converted to carbon dioxide and methane. Methane is a potent greenhouse gas with 20 times the global warming potential of carbon dioxide (EPA, 2014). The more this gas is released into the atmosphere, the higher the rate of global warming. Also, climate change has adverse effects on the natural resources of the country. This is particularly disturbing because a large part of the economy depends on natural resources as a source of living. It is therefore imperative to coordinate all the policies on waste with regard of conditions of environment, consumption and production, industry, agriculture, transport, and trade. Such a systemic view is still lacking all over Africa, especially so in Nigeria, but there are some signs of hope.[21]

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[19] See on the public waste management framework and the private waste collectors' role in Lagos (The Guardian, 13 February 2018): https://allafrica.com/stories/201802130166.html

[20] The approach (by Mbah/Nzeadibe 2016), to move to an inclusive municipal solid waste management (MSWM) system in Nigeria which is based on integrating the informal waste collection sector and founding the policies on the Sustainable Development Goals (SDGs), is of great importance for Nigeria in view of the Agenda 2030.

[21] There is something done at the level of UNECA, African Union, African Development Bank, and UNDP, but the focus is on the continental dimension. There is a gap in looking to policy issues of regions, nations and sub-national entities. The SDRA (Sustainable Development Reports on Africa) by UNECA, namely the Sustainable Development Reports on Africa I-III, give a frame for inclusive policy responses, including waste management; see UNECA Sustainable Development Report on Africa III, 2009, with a chapter 4 on Waste management. The 2018 Africa Sustainable Development Report (ASDR) is discussing the SDGs which have relevance for waste management, such as Goal 6 - Clean water and sanitation; Goal 7 – Affordable clean energy; Goal 11 – Sustainable cities and communities; Goal 12 - Responsible consumption and production; and Goal 15 – Life on land. The report also examines the challenges and opportunities for nurturing Science, Technology and Innovation (STI) hubs in Africa as a fundamental means of implementation of these Goals (see AU et al. 2018). The Africa Sustainable Development Report for 2017 is comparing the 2063 strategies for the African Union and the SDG strategies for Africa (see AU et al. 2017). For access of these reports see: https://www.uneca.org/publications/2018-africa-sustainable-development-report, and https://www.uneca.org/publications/2017-africa-sustainable-development-report. Also,

An examination of municipal waste management in many cities of developing countries, including Nigeria, shows that the present strategies are deficient and need to be re-addressed. Rapid urbanization and waste generation in the developing world, if ignored, can be a threat to health, to the environment and to urban productivity. Cities are known to be engines of economic growth, but the environmental challenges of such growth need a proper assessment. Schiopu et al. (2007) and Schwarz-Herion et al. (2005) have agreed that there is the need to develop, to master and to implement a simple but reliable tool that will help governments in tackling the ever-producing waste in developing countries, such as in Nigeria with its associated high population growth rate. Alternatives to the donor-biased waste management tools are available and are now developed more systematically in African countries; such alternatives have to do with local technologies to manage waste collection and disposal.[22] Although the government of Nigeria is aware of the environmental impacts of improperly managed waste, it appears that it is overwhelmed by the problem of waste mismanagement, missing a real starting point for corrective action. The Nigerian government needs implementable strategies on waste management that are related to disposal, collection, storage, and the recycling of wastes; blueprints are provided in the context of the Sustainable Development Reports on Africa (SDRAs) and the Africa Sustainable Development Reports (ASDRs).

Another approach for designing waste management policies in Nigeria is related to learn from the experiences of a developed country with a sophisticated waste management system. Specific tools, rules, and practices can be transferred to Nigeria, and such experiences can also be transferred from one city (Bremen) to another city (Lagos). Germany has developed a very

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other UNECA reports give a frame for policy integration, such as UNECA 2016 on Greening Africa's Industrialization, with a chapter 4 on The Policy Framework For Greening Industrialization In Africa.

[22] See on technological and organizational alternatives developed locally: https://www.ipoint-systems.com/blog/3-alternative-ideas-for-waste-management-in-developing-countries/; and in the direction of waste management towards a circular economy approach: https://journals.sagepub.com/doi/full/10.1177/0734242X16681406. A new collaborative approach is also emphasized, integrating management ideas of developing countries and of the donors and of the various stakeholders in developing countries: http://www.gdrc.org/uem/waste/swm-fogawa1.htm.

robust waste management system which ensures efficient waste collection, storage, transportation, and disposal while minimizing the impacts of disposal on the environment. In addition, there is emphasis and focus on waste sorting, re-cycling and re-using, including other practices which help to save waste management costs. Sustainable waste management and recycling systems in Germany aim at reducing the quantity of natural resources consumed by ensuring that any resources already taken from nature are reused many times, and that the amount of residual waste produced is kept to a minimum and treated in an environmentally safe way (GIZ, 2014; M. Nelles/J. Grünes/G. Morscheck, 2016, BMU[23] 2018). A major goal in Germany is severing the link between economic output (GDP) and waste increase (net waste/NW[24]). In the years 2000-2015 the process of delinking waste generation from output growth was successful, mostly up to 2012, while from 2012 to 2015 an upward trend of waste intensity (net waste per unit of output) has occurred (BMU, 2018/FME 2018, pages 8-9). Nigeria and other developing countries can learn from the experience of Germany, although country states and municipalities in Germany have quite different strategies and policies. This paper therefore identifies the position of Germany in regard of sustainable waste management systems in the context of other European nations. It investigates the trends in waste generation in the Country State of Bremen in Germany, the smallest country state of Germany. It examines the waste management system in the Country State of Bremen in Germany and confronts it with the Nigerian case. It presents the per capita waste production in the Country State of Bremen in Germany and the means of disposing it, and finally reviews the waste management financing model in the Country State of Bremen in Germany. These objectives were implemented with the hope that Nigeria and other developing countries can benefit from sustainable waste management practices pursued in Germany.

3.0 The Role of the Informal Private Sector in the Waste Management System of Nigeria

Informal private sector involvement in waste management activities in all parts of Nigeria, including Lagos State which is the commercial centre, has yielded a very significant and sizeable

[23] BMU stands for the Federal Ministry For The Environment, Nature Conservation and Nuclear Safety.

[24] NW/Net Waste means that the waste of materials in a project is reduced by the additional recovery of materials so that the aim of zero waste (called "waste neutrality") can be achieved. This has to do with planning, design, reorganizing the use of materials in the supply chain and in the specific project.

result on the environment. The informal private sector is an institution on its own with little knowledge of integrated waste management approaches of collection, transportation, recovery, and recycling. But nonetheless the sector is effective but could do better to recover and to recycle material to industries within and outside the country. The actors of the informal private sector have important functions and are specialized agents.

3.1 The "cart-pushers":

The cart-pushers are sorting out recyclables from the waste stream they collect door-to-door. These activities are instigated by the ineffective performance of government's own waste management agencies. The cart-pushers[25] are involved in house to house collection of waste at a particular fee depending on the volume of waste using carts; they are sorting and recovering the reusable and recyclable items from the waste before disposing the useless ones.[26] Due to the inability of legal establishment and proper regulation of the informal private sector, it is impossible to acquire accurate data of their effort in the waste management industry. It was estimated that over 5,000 cart-pushers are operating in Lagos State, and they cart away huge volumes of waste every day (Opeyemi, 2012). Still, the discussion is open about exclusion/inclusion of the "cart-pushers" in a Sustainable Waste Management System for Lagos State.[27] These people are still needed, despite of some environmental concerns about their activities. Regulatory failures (limited applicability of environmental laws) and market failures (limited role of the formal private waste management sector) cause this dilemma.

[25] Also, the "wheel barrow operators" fall in this category; they use a small hand-propelled vehicle, usually with just one wheel, designed to be pushed and guided by a single person using two handles at the rear, or by a sail to push the ancient wheel barrow by wind.

[26] Too often these people are accused of illegal activities; recently in Lagos 150 cart-pushers were arrested for dumping thrash on the roadside after sorting out recyclables; see: https://cycled.no/lagos-state-governement-arrest-cart-pushers/. There are different arguments based on these accusations. In fact, the "cart-pushers" are the cornerstone of recycling in Lagos— without them a significant quantity of recyclables will end up unrecovered in Lagos. These cart pushers typically have a low-income status, and they do this job to secure honest living in town. Arresting such people is not justified; rather they should be educated and supported to use other places for the unused waste. Also, Lagos State has announced a total ban on the operations of "cart pushers" and "wheel barrow operators" all over the State; see: https://www.vanguardngr.com/2018/01/lagos-bans-cart-pushers-wheel-barrow-operators-streets/. It is argued by the government that the Cleaner Lagos Initiative (CLI) could be undermined by the continuous activities of the "cart-pushers". Their activities will pose a threat to the success of the initiative.

[27] See Oluwole O. Akiyode/Olasunkanmi S. Sojinu (2006a, 2006b) on the relevance of this still ongoing debate.

3.2 The Scavengers:

These are a group of actors which are involved in the sorting and recovering of re-usable and recyclables materials; for example, aluminium, glass, paper, plastics, scraps metal, animal wastes like horn, bones to name a few. Their activities involve going from street to street searching for re-usable and recyclable materials; while some limit their operations to the dumping site others are sorting and recovering. Several million worth of recyclable materials are generated by these actors yearly in Lagos State, and about 50% of the materials are being utilized within the State while the rest is exported to other States and African countries.[28] Sometimes they process the materials in an uncontrollable manner before selling, for example by burning out cables in order to liberate out copper and other metal materials. Educating and training these actors for environmental reasons should be tried much harder than in the past. A more facilitating role of the government towards the scavengers could help a lot (see on such facilitating approaches the study by T. C. Nzeadibe and H. C. Iwuoha, 2008). It is proposed that the scavengers and others involved in the informal recycling activities could be incorporated into new local and Nigeria-wide "resource recovery initiatives" because they are an important component – the driving force – for the recovery of secondary raw materials for the industrial economy of Lagos. The industrial economy of Lagos can gain from their activities, and public-private-informal sector partnerships and donor-NGO-informal sector partnerships could play a significant role.

3.3 The Resources Merchants:

These traders are basically purchasing all the recovered materials from the scavengers. They are either retired scavengers with the inability of sorting at the dumpsite due to their old age or those who are financially buoyant. Some of them transact the business across the country legally, and some sell their materials directly to industries within the country. All the actors in the informal waste management system are recognised on the ground of their effort and their role, but a formalization of their activities is recommended, parallel to adequate financial and technological measures to ensure sustainability (see the case study on Nigeria by Zadawa et al., 2015). But, the

[28] It is interesting to note that over 70% of all the industrial activity of Nigeria are found in Lagos State (according to data from Adebola 2006a, 2006b). This concentration of industry in the State makes it an interesting case of studying the population growth-industrialization-solid waste generation and disposal nexus.

limits of formalization are so clear because of the many regulatory failures and market failures which are affecting the whole system.

3.4 The Recyclers:

These are micro- and small-scale (some of them registered) companies in the informal private sector that convert recovered materials provided by the scavengers, like paper, aluminium, animal by-products, plastics and metals scrap, to raw materials to be used for the consumption of manufacturing sectors. These are companies with a high financial status, using valuable equipment and machines for processing recovered materials into finished items or raw materials for manufacturing of other valuable goods within and outside the country by other industrial sectors. The industries using such materials are plastic industries, paper industries, aluminium industries etc. Some of the materials are exported, thereby generating foreign exchange (see Zadawa et al., 2015). These four groups of actors are a holistic system of waste collection, waste disposal, waste recycling and waste recovery; any reform of the system has to be understood as a holistic reform programme.

3.5 Problems facing the Informal Private Sector in Waste Management of Nigeria:

There are several constraints being encountered by the informal private sector which need both private and government interventions in order to make Nigeria's environment to be conducive for living. The constraints are:

i. Lack of recognition and of financial support by the Government;
ii. Non-provision of basic amenities to support their effort and their activities;
iii. Non-provision of safety equipment to protect the actors from hazardous materials and health risk;
iv. Training of the various groups of actors on materials, types of waste; technologies, finance, and environmental conditions;
v. No access of these actors to adequate medical facilities; and
vi. Lack of proper education, training and orientation on first aid treatment in case of an emergency.

Therefore, a comprehensive formalization/integration programme needs to be started to begin with the formalization and integration of the informal waste management sector on a step-by-step basis.

4.0 The Role of the Formal Waste Management System in Nigeria

While informal waste management systems are dominating in other parts of Nigeria, relative to formal waste management systems, Lagos State has also a rather advanced formal waste management system. As the Lagos waste management system is advanced in Nigeria, it is shortly described in this section. The huge volume of waste being generated since decades in Lagos and the inability of the government to handle this waste effectively have led to the creation of many waste management agencies in Lagos State. Although all the other states in Nigeria have similar agencies and ministries saddled with waste management, these institutions are not as developed as the ones in Lagos State. It is the task of these institutions to manage the collection, transportation, recovery, recycling and disposal of solid waste successfully, but all the effort should yield positive results; therefore, instruments for monitoring, evaluating and comparing the performance of these institutions are needed. Only by such a process it is possible to assess the yield to the economy of Lagos State and of other Nigerian states and to compare the achieved results with the waste management institutions in developed countries, such as Germany and the EU countries. Waste management was for a long time in history not seen as a problem in Lagos state, because the habit of littering the environment has become part of life of most of the inhabitants until the 1970's when Lagos state was tagged the dirtiest city in the world (Adedibu and Okekunle, 1989). By this time, every "nuke and cranny" of Lagos has become a dumpsite, creating embarrassing environmental conditions. The Lagos State Government started to adopt various strategies aimed at tackling these problems. The table 1 below shows various institutions established so far by Lagos state government to combat the problems generated by improper solid waste disposal. The establishment of a formal waste management system in Lagos led to changes in various government agencies; all of them have specific objectives which are believed to create a conducive atmosphere in the state.

Table 1: Metamorphosis of Agencies in Charge of Waste Management in Lagos State, Nigeria

Years of Establishment	Name of the Institution	Supervising Authority
1977	Lagos State Refuse Disposal Board (LSRDB)	Ministry of Works and Transport (MWT)
1980	Lagos State Waste Disposal Board (LSWDB)	Ministry of Works and Transport (MWT)
1991	Lagos State Waste Management Authority (LAWMA)	Ministry of the Environment and Physical Planning (MEPP)
1994	Local Government Councils (LGCs) and LAWMA	Local Government (LG) and Ministry of the Environment and Physical Planning (MEPP)
1997	LAWMA and Private Sector Participation (PSP) pilot scheme in Somolu and Kosofe Local government areas	Ministry of the Environment and Physical Planning (MEPP)
1998	Private Sector Participation (PSP) in Domestic Waste Management on a state-wide basis, and LAWMA handling Industrial Waste	Ministry of the Environment and Physical Planning (MEPP) and Local Government (LG)
1999	Private Sector Participation (PSP) in waste management	All Local Governments/ Ministry of the Environment/ Office of the Deputy Governor
2004-2018	LAWMA and Private Sector Participation (PSP) in waste management	Ministry of the Environment/ Office of the Deputy Governor

Sources: Opeyemi (2012) and LAWMA (2018)

The Lagos State Waste Management Authority (LAWMA) is now the current reformed institution vested with the responsibility of monitoring and collecting all forms of waste, managing the approved landfill sites throughout the state, and campaigning against indiscipline among all inhabitants of Lagos State. The LAWMA, formerly known as Lagos State Refuse Disposal Board (LSRDB), was established in 1977. On 13th March 1979, the Board was officially commissioned and renamed Lagos State Waste Disposal Board (LSWDB), assuming additional responsibilities for the cleaning of primary and secondary drains within the metropolis. The following responsibilities were similarly added over the years:

i. Commencement of the collection and disposal of industrial waste (1980);

ii. Commencement of intermittent emergency flood relief operations during rainy seasons (1981);

iii. Collection and disposal of scraps and derelict/abandoned vehicles (1981);

iv. Removal of illegal structures, erected on the required setback from roads as well as those impeding the cleaning of drains/drainage channels (1984); and

v. Commencement of litter control actions within the metropolis (1984).

In December 1991, LAWMA was made the agency to be responsible for the collection, transportation and disposal of municipal and industrial waste as well as the provision of commercial waste services to the State and to the Local Government Councils (LGCs).

The changes in name and status brought more responsibilities/functions to the organization, and these include collection, transportation and disposal of all waste (industrial and domestic waste, garden and agricultural waste, construction waste, clinical and commercial waste, etc.). Above all, the organization has also the responsibility of managing all the government-approved landfill sites throughout the state (Adebola, 2006a, 2006b, 2004).[29] It is not made clear how the Private

[29] Some more recent data on landfill sites are presented by LAWMA; see: http://www.lawma.gov.ng/inside-lawma/departments/landfill/. But data are provided only up to 2012, and it is not explained why there is no further coverage of dumps to landfill sites. It is referred to 3 major landfills and to 2 temporary sites serving Lagos State. It is not possible to assess ongoing activities regarding the landfill sites. Dumpsite Management is presented as a unit under Waste Management Services of LAWMA.

Sector Participation (PSP) really works since 1997, and what PSP delivers in terms of efficiency and performance. The evaluation of the PSP performance is limited to the early years of 2000' (see Akiyode/Sojinu 2006a, 2006b), but there is a more recent assessment (by Odewumi 2013). The evaluation by Akiyode/Sojinu (2006a, 2006b) concludes that nothing has really changed in Lagos State with PSP, Reasons cited are defective policy, insufficient public enlightenment, lack of proper enforcement machinery, lack of managerial and equipment capabilities among the PSP operators, etc. And in order to change something, it would be necessary to reform the PSP approach in fundamental ways (what is described by Odewumi 2013). It would be necessary to embed the PSP approach into an efficient supervisory body and to request other policy actions, such as creating appropriate legal frameworks, addressing the issues of fee collection for the private operators, providing basic infrastructure (like the landfill site and the transfer loading station), and starting public enlightenment campaigns to convince the people in the city about the importance of such issues like payment modalities and the sorting of waste. But such campaigns will only work in case of a general policy thrust of the people on government. It is also important (as seen by Odewumi 2013) to grant the scavengers and the cart-pushers official recognition and to create a niche for them in the PSP Model. There is a need for continuous forms of monitoring and evaluation on a most up-to-date basis. As described for Benin City and other Nigerian cities (by Ogu 2000), the situation was not much different in other Nigerian cities with regard of PSP (since 1995). So, there is not really evidence enough to say that the formal waste management system of Lagos is now a real model for all cities of Nigeria.

As seen above, the continuous increase in the volume of waste generated on a daily basic was so enormous and overwhelming that the government-owned waste management agency (LAWMA) could not handle anymore the situation effectively. The public authorities were forced to seek for alternatives in order to clean up the city. These developments boosted the interest on the side off LAWMA to cooperate with some individuals and firms (formal private sector participation) who have the financial strength and some level of technical know-how/experience to establish and to grow their company, and with others (actors in the informal private sector) who deal with "house to house" waste collection, transportation and recovery at affordable rates/prices. But, in the first years LAWMA was neither strong in cooperating with the formal private sector nor in

cooperating with the informal private sector. The cooperation strategy of LAWMA never was balanced, and some evidence shows that up to now such a balance could not be reached. By provision of the Environmental Management & Protection Law of 1st March 2017, the LAWMA is re-positioned from an Operator/Regulator into a full Regulator in the Waste Management Sector, in line with the Cleaner Lagos initiative. By this arrangement, public waste operations, domestic waste operations, waste management operations, landfill operations, and transfer loading stations are now – by specific concessions - in the hands of private sector participants (PSP), while LAWMA guides, plans, regulates, models, projects, evaluates, and appraises these practitioners in line with international best practices (LAWMA, 2018). But it is too early to say something about the consequences of this separation of regulation and operation functions.

5.0 Challenges to the Formal Waste Management System in Nigeria

It is necessary to identify the major challenges confronting the formal waste management system of Nigeria. This will allow it to better understand the growth and the structure of the informal waste management system in the country. Generally, the formal waste management in Nigeria is confronted with the following challenges:

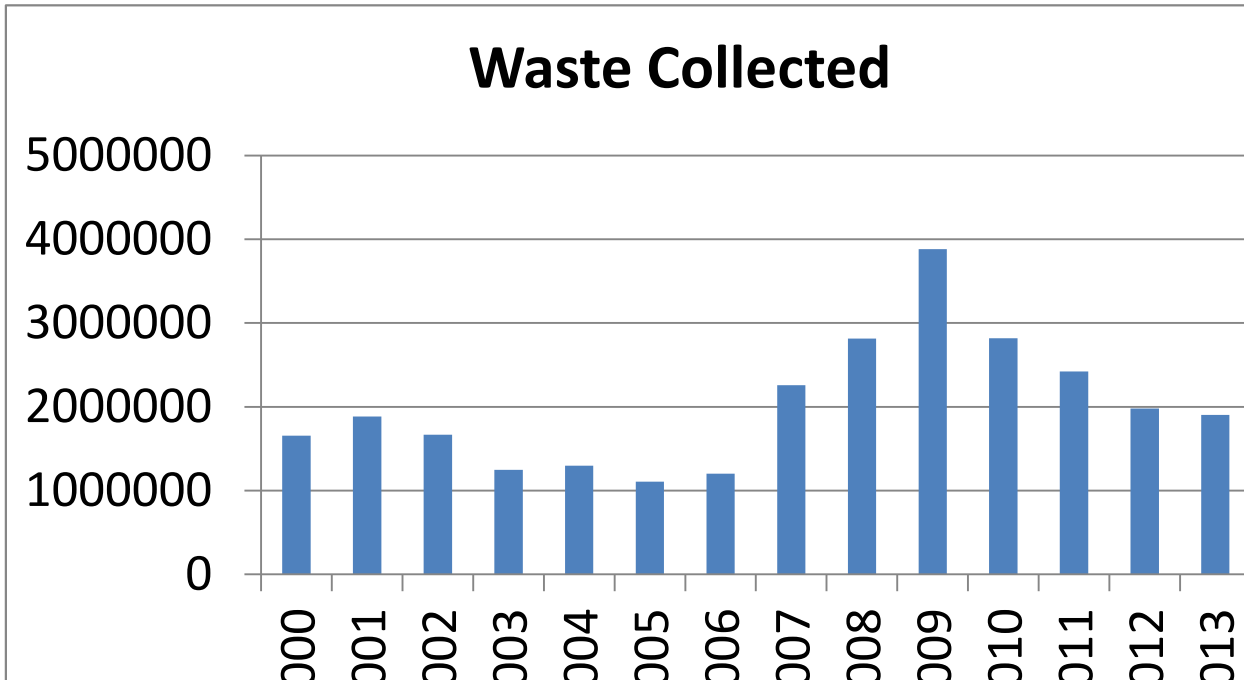
i. Incessant political interferences;
ii. Operational and institutional instability;
iii. Inadequate funding and lack of equipment;
iv. Lack of civil society involvement in decision making processes;
v. Nonchalant attitudes of the staff;
vi. Use of highly sophisticated equipment without adequate technical know-how for its maintenance;
vii. Waste generators (public and private ones) are not willing to pay for the services;
viii. Corruption and mismanagement of funds.

The consequence of these constraints, and the list can be made longer, is that waste is still a big problem in Lagos State and in the whole of Nigeria. Inadequate records of the amount of waste generated in Lagos state have been a serious problem, and the involvement of non-regulated sectors in the collection of solid waste within the state is a major contributor to this data

collection problem. It is therefore no surprise that LAWMA has only data up to 2012 (detailed) and 2014 (general) on its website (see above). Although the participation of informal private sectors and the disposal of solid waste in the state have made Lagos state a more liveable environment in recent years, the lack of a strategy and of a vision in regard of a future-oriented waste management system limit the progress in Lagos State. In order to have accurate data/records of the amount of waste being generated in Lagos state and in Nigeria as a whole, proper surveys need to be undertaken and analysed. This approach will not only enhance the integration of the waste management system within the state, but will give other interested bodies (processing firms, recycling firms, craftsmen, health institutions, housing cooperatives and firms, other waste management value chain stakeholders, etc.) vital information on the waste management system in Lagos state and in Nigeria.[30] So, only estimates are available saying that about 9,000 metric tonnes of solid waste is being generated in Lagos state alone on a daily basis (Opeyemi, 2012). The amount of annual waste collected and disposed formally by the relevant agencies has increased from 1,656,706 tonnes in 2000 to 1,771,259 tonnes in 2014 in Lagos State (see the figure below). And, this is only the formal system of waste collection and disposal. The figures for all the waste are much higher; it is reported that 16 million tonnes are generated (Ibiyemi, 2008). This is an indication of the increase of waste being generated in Lagos and in Nigeria, although it is stated that the state should/could reduce the volume of waste generated by its policies to control the waste generation through waste prevention, re-use and recycling. Figure 2 reveals that since 2009 a downward trend is obvious, but 2009 was the year which saw in Lagos a spectacular increase of waste collected and disposed. This increase in waste generation translates to a growth rate of about 7% within the period (2000-2014). This suggests that Lagos and Nigeria need to do more in terms of waste prevention, re-use and recycling like developed countries, such as Germany.

[30] See on the poverty of waste data for Lagos: http://www.lawma.gov.ng/waste-statistics.

Figure 2: Waste Collected and Disposed to Dumpsite (Tonnes) in Landfills of Lagos (2000-2014)



Source: Computed from LAWMA (2018)

It may be of interest to analyse the waste prevention, re-use and recycling activities in Lagos State more carefully. Also, the ambitions of the state and local government waste management authorities in Lagos State are of interest. Lagos State has seen huge reforms since 2015/2016. All this was intended with the establishment of the Cleaner Lagos Initiative (CLI) in August 2016 by the new Governor who took over in May 2015. But, critical reports about the discrepancies between the rhetoric (the stated goals of CLI) and the reality (the outcomes so far of CLI) in the context of the initiative are becoming now more influential (see as an example the study: "Inside the Cleaner Lagos Initiative"[31]); the report outlines how the established system of waste management based on private formal sector firms and the many informal sector actors is giving way to a fundamentally different system dominated by quasi-monopolistic actors, like the global

[31] See the Report "Inside the Cleaner Lagos Initiative", presented by the Heinrich Böll Foundation Nigeria in 2018 (HBSN 2018), and arguing about the new problems generated by the Cleaner Lagos Initiative (CLI): https://ng.boell.org/2018/01/15/inside-cleaner-lagos-initiative

waste management company Visionscape[32] and Revive[33], a company for the management of dumpsites. Both developments at the company level had serious implications for other formal and informal sector actors in the waste business of Lagos State (see the figure 3 below).

Figure 3: Public Bins, according to the Cleaner Lagos Initiative, under the responsibility of the global waste management company Visionscape

Source: Lagos State Government, Cleaner Lagos Initiative

The Cleaner Lagos Initiative (CLI) was established by executive order, although completed with the backing of a hastily passed Environmental Protection Law which delegates oversight of the

[32] See on Visionscape, calling itself an Environmental Utility Group: https://www.visionscape.group/. Recently the Group had to shut down its operations because of attacks against equipment in Lagos (report October 8, 2018); see: https://nairametrics.com/2018/10/08/visionscape-shuts-operations-in-lagos/.

[33] See on Revive Lagos: https://www.vanguardngr.com/2019/01/why-we-must-theme-up-with-sanwo-olu-to-revive-lagos/

waste management sector to the Ministry of Environment, LAWMA, and the Public Utilities Monitoring and Assurance Unit (PUMAU). The separation of powers (oversight, regulation of operations, and billing) was intended to create a more transparent system. The Report concludes that neither transparency nor efficiency of the system could be improved so far.

6.0 The Relevance of Integrated Sustainable Waste Management (ISWM) Systems for Nigeria

Integrated Sustainable Waste Management (ISWM) Systems are mainly discussed for cases of developed countries, but the policy issues discussed are highly relevant for developing and emerging countries, and even for least developed countries. ISWM systems are based on multiple objectives, and health and safety, environmental, economic and social objectives of waste management matter for countries like Nigeria. It is obvious that countries which are based on both, formal and informal waste management systems/sectors can use the advice from the case studies of ISWM in the developed world. McDougall et al. (2001) defined Integrated Waste Management (IWM) systems as the combination of waste streams, waste collection, waste treatment and waste disposal methods, with the objective of achieving environmental benefits, economic optimization and societal acceptability. The initial basic principles of waste management were developed primarily to protect and to safeguard human beings and its environs from harmful substances. Managing waste is another major concern which needs to be addressed for the betterment of the future generation. The two fundamental concerns are: minimizing waste and then establishing an effective system for managing the waste still produced. The priority of a solid waste management system is to ensure human health and safety; all the interventions should be designed to protect workers and the general public by preventing the spread of diseases. Additionally, other objectives of sustainable systems of solid waste management are the following: to be environmentally effective[34], to be economically affordable[35], and to be socially acceptable[36]. Obviously, it is easier said than done to achieve all these objectives at the same

[34] The waste management system must be able to protect the environment from improper disposal of waste that can cause hazardous effects.

[35] The general public should be able to afford the cost placed on waste operations by the waste management system. This means that the cost of an effective waste management system should consider the living standard of the people in such a community.

[36] For a waste management system to operate effectively, public cooperation is important. Moreover, as responsible institutions for waste management they should always try to provide vital information, educate, develop trust and

time without any trade-off. In order to avoid high costs of such trade-offs, it is necessary to approach the waste management problem simultaneously, by reducing effectively the environmental burden of the society and the economy through the establishment of a waste management system which is also economically affordable and socially acceptable. Such a system needs to be implemented as being based on a practical (functional and operational) model and needs to be continually monitored, evaluated and improved; such a model is aimed at in the context of ISWM discussions (McDougall et al., 2001). However, data are not available at an internationally comparable level based on agreed standards.[37]

The principles for integrated sustainable waste management (ISWM) have been developed and elaborated further by other authors (Van De Klundert, A./J. Anschutz, 1999). Based on the principles of ISWM (since Van De Klundert, A./J. Anschutz, 1999, McDougall et al. 2001, and others), the technology selection should be based on local spare parts availability. Indigenous and locally manufactured technology should be selected. A long-life span technology with a good and reliable quality should be selected. The systems should be adapted to the physical environment, to the topography and to other physical requirements of the region. Precaution and maintenance procedures should be well developed. Effective systems to ensure a maximum utilization of the equipment should be incorporated. Safety of soil, air and water at all regions should be preserved. The adoption of the hierarchy of waste management, in order to reduce waste and to promote proper collection, disposal, re-use, sources separation and recycling,

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gain support from the community. Provision of bins or containers for collection and sorting of waste is another means by which recycling can be effective in the communities.

[37] This is evident when looking at the most recent UN environment statistics in a snapshot for Nigeria (2014); There is no information presented on: Total population served by municipal waste collection (%); Municipal waste collected (1000 t); Hazardous waste generated per capita (kg); Proportion of hazardous waste treated or disposed (%); Proportion of municipal waste recycled (%); see:
https://unstats.un.org/unsd/environment/envpdf/.../Nigeria.pdf.
All the other entries on UN environment statistics are filled for Nigeria, but not the category "Waste". The World Bank study (The World Bank, 2012) gives more tables in comparison for developing countries, but the situation for Nigeria is extremely weak. International data on MSW generation per capita are not readily available and comparable, so that changes of the waste intensity for countries like Nigeria cannot be assessed (see Kawai/Tasaki 2016); see:
https://core.ac.uk/download/pdf/81531242.pdf.

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should be emphasised, but always in the context of the prevailing local and environmental conditions. Proper waste treatment to recover the resources to source should be encouraged. The "beneficiary principle" (paying adequately for the services of a functioning waste management system) should be applied to all sectors/actors/consumers and producers. Apart from the direct payments (fees) for waste collection and disposal by the ultimate users of (public and private) waste management facilities, all other sectors/actors which are benefitting from waste management activities should pay taxes and contribute to the municipal revenues base which is used for waste management services. The payment should be adequate/reasonable, transparent/inclusive, and it should be determined in a consultative/participatory manner. Services to all strata of the population, regardless of their ethnic, cultural, religious or social background, should be provided. Users' opinions should be considered on the aspect of quality and pricing of the services and on the intended changes in service delivery when it is needed. Services should be adapted to user demand and priority. Provision of incentives to firms and groups of users, and policies of recruitment and promotion should be based on credibility. "Social privatization" should be encouraged; local communities, social entrepreneurs and local cooperatives should be encouraged to apply for licences. "Sustainability" of waste management processes should be promoted by government (at all government levels) as well; sustainability can be defined more narrowly or more widely so that (measurable) criteria are needed for the whole waste management value chain. Inter-sectorial cooperation among other urban systems should be incorporated into the waste management system; also, inter-regional cooperation has a role to play. Private sectors should be allowed to express their competency on waste management, thereby avoiding a dominance of single firms/suppliers along the waste management value chain. Licences should be awarded for a limited period, so that competitors have a chance to enter the system. The waste management system must give all stakeholders opportunities to partake in planning and implementation, especially the weaker and the less privileged groups (especially people in low-income areas, poor and ultra-poor people, ethnic minorities, and informal micro and small firms may be vulnerable to waste management interventions). The means and rights for monitoring, accountability and raising complaints should be provided. The participation of non-governmental actors and of the private sector in the system should be initiated and encouraged. The system must be supportive of decentralization of

tasks, authority and finance. Decision-making at the lowest level of authority should be encouraged, so that localities are participated in all the processes, policies and issues regarding financial matters and the selection of technologies. Waste management must be given a high priority in both policies and budgets at all government levels; this situation is only possible to reach if there are fora for the participation of the people. The system should support in principle the "waste management hierarchy", which gives preference to waste prevention, source separation, re-use and re-cycling, above mere collection and disposal (Opeyemi, 2012). But the local conditions will determine the extent of following the guiding principles of the "waste management hierarchy".

7.0 Applying the Concept of an Integrated Sustainable Waste Management System in Nigeria

Waste management systems in the cities of Nigeria could not be managed without the informal sector, but this is not a new insight.[38] The issue is more how to integrate the formal and informal sectors of waste management so that integrated systems are made workable (Dhillon and Sandhu, 2017). The informal waste management sector contributes significantly to the waste management of cities, by collecting, sorting, processing, storing and trading waste materials in the recycling value chain as indicated previously (Gupta, 2012/2014). It is even possible to extend the range of activities of actors in the informal waste business towards manufacturing and services activities[39]. According to Gerold (2009)**,** many more tons of recovered materials come via informal channels than via formal channels in developing countries. In most developing countries, while the formal sector handled about 3% of waste generated, about 18% was managed by the informal sector **(**CWG-GIZ, 2010; UN-HABITAT/Scheinberg et al., 2010)[40]**.** Generally, policies that facilitate the integration of the informal sector into the waste

[38] The International Labour Organisation (ILO) defines informal sector waste workers as individuals or small and micro-enterprises that intervene in waste management without being registered and without being formally charged with providing waste management services (Dhillon and Sandhu, 2017).

[39] See Gupta 2012/2014 on these issues: Integrating the informal sector for improved waste management. https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Integrating_informal_sector_improved_waste_management.pdf

[40] Attitudes of municipal authorities towards the informal sector differ from place to place: in some places there is hostility, in other places there is indifference, and in some other places these informal actors are regarded as a

management system will result in an increase in the rate of material recovery. Consequently, disposal rates will drop, allowing for savings in transportation and landfill operations. Therefore, the participants in informal sector waste management in Nigeria should be regarded as a useful part of the waste management system and must be given the opportunity to enhance their livelihoods in managing waste in a sustainable manner. The role of government is also critical and important in mobilising the informal sector and in integrating it with the waste management sector in Nigeria (Gupta, 2012/2014). The integration of formal and informal waste sectors in Nigeria will promote social acceptability of the evolved waste management system. Social acceptability of waste management will improve the sustainability of the waste management system in Nigeria. Social acceptability of informal activities can be strengthened by new forms of cooperation with formal actors.

From a technical, social, economic, financial, institutional and environmental perspective, the waste management system in Nigeria should be designed in a way to be appropriate to the local conditions in which it operates. The system should be capable of maintaining itself over time through mobilizing the resources it needs. This implies that the waste management system in Nigeria can be fully integrated and sustainably managed if the machines and the equipment being used are locally manufactured and based on indigenous technology; on this basis the equipment and machinery can be geared towards efficiency and optimum utilisation. This machinery and equipment must be adapted to the local availability of spare parts, while durability and good quality material are preconditions for efficient products. This will also ensure the highest productivity of labour and capital in the local environment. The Nigerian Universities and other research institutes can fabricate waste management material and equipment being adaptable to Nigeria's local environmental conditions. The manufacturing of that equipment can start with the manufacturing of the materials and the equipment being used mostly by the informal waste management sector, and this production can be scaled up to other materials and equipment being used by the formal waste management sector. The National Plastic Recycling Programme (NPRP) in Nigeria is a good example of such an initiative; local expertise can be used for local

useful part of the waste management system and are given the opportunity to enhance their livelihoods (Gupta, 2012/2014).

manufacturing and re-manufacturing for waste recycling equipment at appropriate scales.[41] All these will discourage the importation of heavy-duty equipment which are difficult to maintain and to use by the local actors in the management of waste in Nigeria.

In Nigeria, inter-related collection and treatment options can be scaled up based on different habitats (household, neighbourhood, city). This suggests that informal waste collectors can be assigned to collect waste in areas where heavy trucks will find it difficult to access. In this case, the upgrading of the informal sector could be done by integrating waste pickers directly into collecting waste at source (Gupta, 2012/2014). This suggests that informal waste management in Lagos, but also in other Nigerian cities, must be accommodated or included in planning and executing of 'Cleaner Lagos Initiatives'[42]. This will create room for the involvement of all stakeholders in planning and implementation, especially the weaker and the underprivileged groups[43]. It has been said that the true test of any government lies in the way it responds to its most vulnerable citizens. Incorporation of underprivileged groups and vulnerable citizens into the Cleaner Lagos Initiative (CLI) will be an opportunity for the Lagos State Government to demonstrate its commitment to the wellbeing of every citizen in the state. Therefore, rather than edging out the scavengers from Olososun dumpsite, these workers need to be given protection within the framework of the CLI that will enable them to co-exist profitably with formal operators. To this end, Lagos state needs to re-envision itself as a mediator between the formal and informal sectors, enforcing boundaries for the former and enabling participation by the latter.

Informal waste management (IWM) can also be integrated into the formal waste management system by facilitating their activities, by organising them, by providing them with training, by promoting them (advocacy), and by supporting them with research, technical or financial

[41] See on the programme: chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-CW...

[42] The Cleaner Lagos Initiative (CLI) is geared to meeting the current and future environmental management situation, and to reform and to transform the landscape of Lagos State. See: http://www.lawma.gov.ng/cleaner-lagos-initiative/; but the description of the initiative through LAWMA is rather weak. Some detailed reports about cleaning initiatives give evidence of real ongoing action, but it is not clear what is new since CLI was introduced; see: http://www.lawma.gov.ng/cli-reports/.

[43] Involvement of stakeholders is one of the pillars of sustainability of a system, leading to a feeling of responsibility for the success of the system, at least if their political and economic interests are served with the system, and if there is a willingness to keep it going on the part of stakeholders.

assistance. The informal waste management sector in Nigeria can be organized to form cooperatives as the case of India shows where solid waste collection and handling (SWaCH) has been authorised by the Government to provide door-to-door waste collection and other allied waste management services.[44] SWaCH bridges the garbage gap between people's doors and the Government assigned collection points. It has been reported that this service offered total solutions for wet garbage and dry garbage, while enabling the waste pickers and collectors to keep their livelihoods and to get trained to carry out their work professionally and in an occupationally safer way. The integration of the waste pickers through SWaCH in India has helped to reduce waste disposal by more than 20%. Regularising and integrating informal recovery into the overall solid waste management system could enhance recyclable recovery rates and reduce overall solid waste management costs in Nigeria (Gupta, 2012/2014).

The waste management system in Nigeria must be based on the 'all the beneficiaries contribute principle', i.e. besides the waste generators paying user charges, the resource recovery sector and the local government should also contribute by respectively paying a profit tax and allocating municipal revenues to waste management. The good example of 'all the beneficiaries contribute principle' is the Tertiary Education Trust Fund (TETFund) arrangement to fund tertiary education in Nigeria. All the companies registered in Nigeria pay 2% of their profit as education tax which is being managed by TETFund for the rehabilitation, restoration and development of tertiary education in Nigeria (TETFund Act, 2011). This model could be used for financing

[44] See: https://swachcoop.com/. The organization is described as follows: "SWaCH (Solid Waste Collection and Handling or, officially, the SWaCH Seva Sahakari Sanstha Maryadit, Pune) is India's first wholly-owned cooperative of self-employed waste pickers / waste collectors and other urban poor. The organisation was the joint effort of Pune Municipal Corporation and the waste pickers' union Kagad Kach Patra Kashtakari Panchayat (KKPKP). In 2008, PMC (Pune Municipal Corporation) signed a five-year Memorandum of Understanding to decentralise door to door collection services and allow SWaCH members to carry out this work. Through its 2300 members, SWaCH services over 378,419 households across 76 prabhags in 15 municipal administrative wards of the PMC." See: swachhbharaturban.gov.in/.../Zero_garbage_modelPune.pdf. The coordinators play a great role: "While garbage is collected from each household by self- employed waste pickers themselves, the basic unit for ease of coordination is an electoral ward or a prabhag. There are 76 such prabhags in the city which are staffed by coordinators. Each prabhag has a coordinator who liaises between the citizens and the waste pickers as well as the PMC staff for the smooth collection and disposal of garbage. The coordinators work with the SWaCH waste pickers and liaise with the PMC staff and the citizens in order to ensure that the system runs on oiled wheels."; see: https://swachcoop.com/about/prabhag-coordinators/

waste management in cities and areas of Nigeria.[45] It may make financial and economic sense to emphasize labour-intensive rather than capital-intensive systems in waste management in Nigeria. Cooperatives and informal sector associations may be helpful in this direction. This will not only reduce the cost of waste management but will also engage the teeming population of unemployed youth in Nigeria.

Waste management charges which are introduced should also be adapted to the 'ability to pay' principle, including for example higher charges for industrial and commercial companies, and as well for cosmopolitan areas, such as Ikeja, Lagos Island, Obalende, etc., in Lagos State, thus ensuring a cross-subsidisation between high- and low-income users. Communities which are not able or willing to pay for expensive services should be given the option of receiving a cheaper yet still effective service, e.g. block collection instead of door-to-door collection. In this case, central collection points can be established where the informal collectors will dump the waste collected from interior and remote places at cheaper rates and the formal waste collectors can pick the waste from the central collection points. Regrettably, such a model of cooperation between formal and informal waste system actors is not widely used in Nigeria, although experience shows that it can work if supported by all the stakeholders in the system.

It is obvious that in countries like Nigeria a simple system would serve best the needs of integrated solid waste management. Four urgent tasks are recommended: First, *data collection* on waste composition as good data is the foundation of effective IWM (Integrated Waste Management) systems. Second, progress is needed from uncontrolled dumping to the *use of simple sanitary landfills* as experience shows that such alternatives to uncontrolled dumping sites are feasible. Third, *separation of organic waste from municipal solid waste* is needed as composting is feasible and economic as fertilizer. Fourth, *a formal involvement of scavengers* in

[45] The system was established by the Federal Government of Nigeria in 2011, to disburse, to manage and to monitor the education tax to government-owned tertiary institutions in Nigeria. The scheme was formed as a product of the Education Tax Act of 1993. Prior to the establishment of the scheme in 2011, government-owned tertiary institutions were poorly funded. The scheme was designed to improve on the management of funds disbursed to these institutions. Source of information: Wikipedia (https://en.wikipedia.org/wiki/Tertiary_Education_Trust_Fund).

the collection of recyclable materials is a bridge between formal and informal waste management systems (see McDougall et al., 2001). The established waste management hierarchy may be too inflexible/too rigid for local situations in countries like Nigeria; adaptations may be useful. Four issues/cases matter in this context (see McDougall et al., 2001). It is evident that in regard of all four issues/cases informal sector workers in waste management benefit from a transition to simple, low-cost solutions towards waste management. First, moving from dumping to sanitary landfills may be feasible as a financially most realistic option although it is not the best solution according to the established waste management hierarchy. There are low cost options available for landfilling (by selecting properly the site, by organizing the filling on a cell by cell basis, by using cover material at the end of each working day, by separating organic waste and recyclable material if possible, by fencing the site, etc.), but these options need to be discussed openly and then implemented. Second, separation and treatment of organic waste is another low-cost possibility for waste management in Nigeria which can create employment of low-skilled workers and enhance the environmental situation in various ways. This can be done at the level of households and prior to final disposal at landfills. At the household level waste advisers and school programmes will be helpful to make educational programmes more effective. Simple instructions – equipped with pictures – will be supportive. Learning from the Indian system of composting organic waste could be an opportunity, as it is profitable for all stakeholders there. Composting by piling organic waste in long rows by using turners (windrow composting) can be the basis of organic fertilizer which has a market in rural areas, but also in urban gardening. The compost can also be used to cover the landfill (all depends on the economics of land use in the area). Labour-intensive works play a role in collecting, separating and treating organic waste up to composting. Low-cost public works programmes can be created by municipalities in urban areas and by regional councils in rural areas. A third possibility to use low-cost actions in waste management is for recycling and scavenging. Action is needed when people are scavenging at landfills/dumps. To avoid severe threats to health, separation needs to start early in the waste chain. At the level of landfills/dumps specific educational and training programmes are needed to protect the waste workers. Nigeria can benefit from low-cost sorting facilities which are used in suburbs of Mexico City, and now also elsewhere in the country. Scavengers are involved in a formal system whereby simple material recovery facilities are built in which scavengers are

sorting the waste. Threats to health can be minimized and material recovery rates can be maximized. The pieces of the equipment used for such simple material recovery facilities can be produced and maintained in Mexico, but this solution is also applicable in Nigeria. The evaluation of the "Mexico scavenger model" shows that there are many advantages of the system (in terms of employment, living and working conditions of scavengers, social protection, health, more children of the scavengers going to school, higher recovery rates, higher recycling rates and higher landfill diversion rates). Also, the training programme for scavengers in Brazil is of interest to Nigeria, as the public waste management service improved considerably thereafter. EXNORA, a non-governmental organization in India, is also active in waste management.[46] It came up early in Madras (now Chennai, Tamil Nadu) with a plan to allocate streets to scavengers who are then responsible for separating waste in this street. They are responsible for street sweeping, collecting of MSW, sorting of recyclables, and disposing of the rest-waste to the next municipal transfer sites. They also bring organics to composting sites, using very simple composting facilities. EXNORA has called very early this project "Zero Waste" because of minimizing the residual waste for disposal. Fourth, in the longer-run the successes with options one to three discussed above will make feasible a residual waste incineration strategy. Energy recovery is dependent on successes with removing organic waste from the MSW stream. There are many successful examples in developing countries of involving scavengers into formal waste management systems while preserving their jobs, but at higher quality levels (higher productivity and efficiency, less health threats and pollution, employment creation by using local equipment, creating an integrated waste management value chain by bridging formal and informal actors, etc.). Bridging formal and informal stakeholders in the value chain is important as market development, market organization and market research (for recyclables, compost, local equipment, etc.) is a set of tasks which is benefitting all the actors along the whole value chain. Based on these low-cost options, the Integrated Waste Management (IWM) and Life Cycle Inventory (LCI) approaches can be implemented also in developing countries such as Nigeria. It is astonishing that the many interesting examples presented since 2001 on waste management in

[46] See: http://www.exnora.org/; EXNORA is named after combining three words; the name is derived from EXcellent, NOvel and RAdical. EXNORA is pushing for new ideas in solving environmental problems by involving those who caused the problem.

developing countries (see especially McDougall et al., 2001 and the other literature cited in this report emanating since the turn of the century on waste management in developing countries) did not result in more constructive action, but mostly in plans and institutions.

8.0 Waste Generation and Waste Management in Germany: Structures, Trends, Strategies and Policies (With Implications for Waste Management Reforms in Nigeria)

It is of interest to study the Waste Generation Structures in Germany and the Waste Management System of Germany.[47] The German waste management system consists of various groups of main stakeholders: About 1,000 municipal and private waste management companies (from one-man-firms to large international companies) fulfil the tasks of waste collection, recovery and disposal in domestic waste handling, with municipal companies accounting for a share of 35% and the private companies for a share of 65%.[48] A huge number of enterprises in the German waste disposal and environmental cleaning business is counted: in the year 2014 4,565 enterprises are dealing with waste disposal and the removal of environmental damages. The industry had around 267,000 employees and an annual turnover of 70 billion Euros.[49] Modern and innovative equipment needed for waste collection and treatment is supplied by the mechanical and plant engineering industry that has been one of Germany's most innovative and successful sectors over last decades. The industry is an important international supplier of waste

[47] Germany's waste recovery rates are the highest in the world and show how the circular economy contributes to sustainable economic production in the country by saving raw materials and primary energy. https://www.bmu.de/en/topics/water-waste-soil/waste-management/waste-policy/

[48] The waste management industry is specialized; beside of the waste collectors 12 categories in the waste recycling business can be mentioned: https://www.environmental-expert.com/waste-recycling/companies/location-germany; see for a list of waste management companies also: https://www.environmental-expert.com/companies/keyword-waste-management-272/location-germany and: https://www.environmental-expert.com/waste-recycling/waste-management/companies/location-germany.

[49] See on the data: https://wertstoffblog.de/2017/03/14/deutsche-abfallwirtschaft-zahlen-daten-und-fakten/; the majority of enterprises (2,245) is involved in collection, treatment and removal of waste, but many companies are working in the recycling business. Looking at the facts about the German waste management industry, the great number of companies has also to do with the specialized nature of treating types of waste in Germany; see the most recent report on the German Waste Business for 2018 (BMU, Abfallwirtschaft in Deutschland 2018, and FME, Waste Management in Germany 2018) of the German Ministry for the Environment/Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit/BMU: https://www.bmu.de/publikation/abfallwirtschaft-in-deutschland-2018-1/. For the English version of the Report see: www.bmu.de/en/publications, and for a direct download:
https://www.bmu.de/.../Daten.../abfallwirtschaft_2018_en_bf.pdf.
The report even gives a figure of 11,000 companies being involved in the "circular economy" (page 5), although referring to the same number of employees and the same level of turnover of the industry.

management and environmental protection technologies.[50] A great number of firms in the services sector complement the firms in the waste management and waste technologies sector. The specific regulative framework for waste management is set by the authorities at the Federation (Bund), the country states (Länder), and at a regional and municipal level. The distribution of competences between the government levels and between public and private waste management authorities, agencies and firms is generally regulated by the Circular Economy Waste Management Act (Kreislaufwirtschaftsgesetz). This Act distinguishes waste by their further use: 'Waste for Disposal' vs. 'Waste for Recovery', as well as by their source: waste coming from private households vs. commercial/industrial waste. "Waste for disposal" from all sources and "waste for recovery" from private households can only be handled by public waste management firms, whereas commercial/industrial waste for recovery can as well be recycled by private companies. Exceptions from the obligation of having waste from private households and waste for disposal handled by public waste management firms exist for a range of cases, e.g. direct disposal by a waste producer, transfer of the obligation for disposal to third parties, and not-for-profit waste collection. Commercial and industrial enterprises are obliged to take their packaging waste back, due to the Packaging Ordinance that came into force in 1991. In order to promote market competition, services for collecting, sorting and recycling of packaging need to be put out to tender. The German Länder have the right to establish own regulations regarding the handling of waste through public or private firms, in order to ensure an environmentally-friendly waste management behaviour. This applies, especially, to waste streams that require a close monitoring (especially hazardous waste). These waste streams need to be left entirely to the Country State (Länder)-owned corporations for hazardous waste. With privatization expanding in the waste management system, as in most other sectors formerly dominated by public institutions, the constellations in the German waste management system might change depending on the future development of German and EU legislation.[51]

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[50] Germany is the leading exporter of environmental goods of all types; see: https://www.umweltbundesamt.de/en/press/pressinformation/germany-still-worlds-lead-exporter-of-environmental. See also the brief of 2019 on the exports of environmental technologies by GTAI (Germany Trade & Invest):
https://www.gtai.de/...environmental/fact-sheet-environmental-tec...

[51] See on these frameworks and policies for Germany and the EU: https://www.bmu.de/en/download/waste-policy-in-germany-and-the-eu/; in the context of the EU regulations and directives have to be distinguished. Waste disposal is governed by various European regulations and directives; the former automatically apply to each of the

The shortage of landfill capacity in the 1980s, coupled with the realisation that Germany needs to curb the use of natural resources and energy, prompted the development of a modern waste management system in Germany[52]. Figures (from BMU 2018, p. 9)) show that the waste intensity (net waste volume generation by economic output/GDP price-adjusted) could be reduced sharply from 2000 (index basis 100/100/100) to 2012 (index values 82.0/113.9/72.1), but the intensity ratio is again on the increase up to 2015 (index values 86.4/118.3/73.3), according to data from the Federal Statistical Office (FSO) for 2017. The German public is generally aware of the importance of waste separation and recycling. Modern sorting, treatment and recycling technologies are now well-established, and recycling capacity has been expanded (BMU/Jaron and Kossmann, 2018). Waste management in Germany has evolved into a large and powerful economic sector. There are more than 270,000 people working in some 11,000 companies of the "circular economy" with an annual turnover of around 70 billion euros. More than 15,500 waste management facilities help to conserve resources through recycling and other recovery operations. Germany's high recycling rates of 67 per cent for household waste, around 70 per cent for production and commercial waste, and almost 90 per cent for construction and demolition waste speak for themselves (BMU/Jaron and Kossmann, 2018)[53].

The volume of waste generation has decreased since 2000 in Germany. This decreased from 406.7 million tonnes in 2000 to 351.2 million tonnes in 2015 (BMU 2018, FSO/Federal Statistical Office, 2017). This translated to about a 14% decline in waste generation in Germany. But, in the year 2011 the volume increased against the year 2009. And, since 2012 and up to

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member states, while the latter must be separately transposed into national law by each member state. The basis of this legal framework is the Waste Framework Directive (2008/98/EC); it defines the main waste-related terms, lays down a five-step waste hierarchy, and contains key provisions of relevance for the German waste disposal law. The Waste Management Act (Kreislaufwirtschaftsgesetz) transposes the directive into German law. See on the various laws and directives at different levels of governance EU/Germany: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-regulations.

[52] The "circular economy" is a top priority for environmental policy in Germany, and since the early 1990s work has been on-going to transform the waste management system into a resource management system. Germany is aware that a growing global population is reliant on diminishing resources. Germany, with its well-developed industry, but above-average per capita consumption of resources, has a great economic interest in moving towards a "circular economy", but sees also a great responsibility here.

[53] The "circular economy" is a global task, and German companies, scientific institutions and government players can make an invaluable contribution with their expertise, their services, and their state-of-the-art technologies.

2015 the waste volumes generated are continually on the increase. The data show that it was high time to introduce new measures to prevent further increases of waste generation. The German Waste Prevention Programme, adopted in 2013, outlines existing and potential waste prevention measures at national, regional and local level. Alongside a host of advice, information and awareness-raising measures, together with research and development projects, the programme also focuses on waste prevention strategies and incentives. Total waste volumes decreased up until 2009, largely independently of economic influences. They then increased at a moderate rate, but far less sharply than economic growth[54]. This is reflected in the waste intensity indicator (ratio of net waste generated to total GDP), which dropped from an index value of 100 in 2000 to 72.1 in 2012 but increased slightly to 73.3 in 2015. It should be seen that in Germany waste prevention aims to reduce both, the volume of waste and the pollutant content of the waste. Government-directed waste prevention efforts should have contributed to this effect, by focusing on durable, lean, and repairable products; by avoiding unnecessary and short-lived items; by purchasing services rather than goods; and by using the services of products rather than owning the products (BMU 2018, English Version: FME 2018, pages 10-11). The effect of the waste prevention interventions seems not to have worked in the anticipated direction. New waste prevention strategies with more effective regulations and incentives and new trends in production and consumption may be necessary.[55] As well as decoupling waste volumes from economic output, there is an increasingly pressing need to recover raw materials and energy carriers from waste and return them to the industrial cycle in Germany. Waste prevention and the resource-efficient, environmentally sound recovery of valuable materials are the hallmarks of a modern

[54] From 2000 onwards, economic output in Germany rose at a moderate rate, dipped sharply during the financial crisis years of 2008 and 2009, and since then has increased steadily.

[55] Sustainable Development Goal (SDG) 12 on Responsible Consumption and Production may give the direction (along the mentioned targets and indicators for SDG 12). As an example, Germany tries to improve the supply chain of textiles from low-income Asian countries to Germany through a pact of producers towards more sustainability along the whole value chain; see: https://www.bmz.de/de/ministerium/ziele/2030_agenda/17_ziele/ziel_012_konsum/index.html. The so-called "Pact for Textiles", promoted by the Ministry of Economic Cooperation and Development/BMZ, is a voluntary one, and so it may be difficult to reach a more sustainable production (in Asia) and consumption (in Germany) of textiles.

circular economy in Germany (BMU 2018, English Version: FME 2018, pages 12-16). In Germany, the core elements of the circular economy are set out in the Circular Economy Waste Management Act (KrWG), which entered into force on 1 June 2012. The Act transposes the Waste Framework Directive of the EU into national law and outlines the legal basis and the fundamental principles of the circular economy. Beginning with the legal definition of waste, the core principles include the polluter-pays principle, the five-tier waste hierarchy principle, and the principle of shared public and private responsibility for waste management. The purpose of this Act is to promote the circular economy to conserve natural resources and to protect human health and the environment from the impacts associated with waste generation and management.

Nigeria can benefit from Germany's steps in the direction of moving towards a "circular economy", by learning from Germany's data generation strategies (like calculating the "waste intensity" of GDP), by assessing like Germany continually the development of the environment goods sector (by companies, employees, human skills), by looking like Germany at the trade of environment goods (by types of goods and modalities of trade), and by considering like Germany carefully the hierarchy of waste management goals in relation to the Nigerian federal structure. Important is also the lesson that Germany improves its laws and regulations after some time if the success of interventions is not coming forth, if implementation of intended measures is weak, and if institutions fail to deliver. Some form of competition between EU countries over waste management interventions and outcomes, as analysed by rankings, comparative studies and peer-reviews, is helpful in this context (see below).

8.1 Waste Prevention in Germany

In the interest of conserving resources, waste prevention in Germany aims to reduce both the volume of waste and its pollutant content. To this end, in 2013 the German government and the Federal States (Länder) have adopted a programme of public sector measures designed to reduce the waste volumes[56]. There are also many other ways for producers and consumers to reduce their waste: by focusing on durable, lean, repairable products; by avoiding unnecessary and short-lived items; by purchasing services rather than goods; and by using rather than owning the

[56] The Waste Prevention Programme (WPP) of Germany will be revised and updated in 2019.

services of products, like cars and equipment. The message is that by acting considerately, all people can do something to protect the environment. Raising awareness and sensitizing the general public to effective waste prevention is therefore crucial. Each year in November, Germany stages its own series of events to mark the European Week for Waste Reduction (EWWR), highlighting what can be achieved through individual activities, ideas and commitment.[57] The approach to reduce the use and spread of plastic bags is a good example. Although Germany's consumption of plastic bags was already below the European average, at around 72 bags per person per year, the voluntary introduction by retailers of a plastic bag charge has reduced this number further to around 38 bags, proving that conscious behaviour by individuals can have a big impact (BMU/Jaron and Kossmann, 2018, English Version: FME 2018, page 11). The voluntary measures approach is often criticised, but it is argued that the coordination of all concerned stakeholders may be an appropriate way to sensitize producers, consumers, retailers, and other stakeholders over time. The EWWR is a symbol for the voluntary character of the waste prevention initiative. In Germany, The Federal Environment Agency (Umweltbundesamt/UBA) is the EWWR partner for actions in Germany; since 2014 the German association of local utilities (VKU/ Verband kommunaler Unternehmen) has been coordinating the campaign week. The Federal Environment Ministry (BMU) is the EWWR's official partner.[58]

Implications for Waste Management Reforms in Nigeria: In Nigeria, "waste prevention" is rarely discussed. Only few references can be found in the literature (see as an example the survey by Oyebode 2018). It is argued that "waste prevention", which is also called "source reduction", seeks to prevent waste from being generated. Waste prevention strategies - according to Oyebode 2018 - include using less packaging, designing products to last longer, and reusing products and materials. Waste prevention strategies help to reduce handling, treatment and disposal costs and ultimately will reduce the generation of pollutants which are escaping to atmosphere from waste treatment and disposal processes. However, concrete steps to go ahead with such waste prevention paths are not proposed and are not really part of the announced strategies of municipal waste authorities in Nigeria.

[57] See more about the European Week for Waste Reduction: http://www.ewwr.eu/de/project/main-features
[58] See: https://www.bmu.de/en/event/europaeische-woche-der-abfallvermeidung/

8.2 Recovery and Disposal of Waste in Germany

The goal in Germany is to transform the waste industry into a source of raw materials to be used for producing new goods. The waste management sector contributes to sustainable production with high recycling and recovery rates, which in turn help to save raw materials and primary energy. Germany devised a resource efficiency programme, and an updated version (ProgRess II) was adopted in March 2016.[59] Figures reveal that the recovery and disposal rates have developed satisfactorily since 2000. While in the year 2000 68% of waste were recovered and 32% were disposed of, since 2009 and up to 2015 the recovery rate is at 79% and the disposal rate at 21% (BMU 2018/FME 2018, page 12). This means that in the period 2009 to 2015 no real progress was achieved, what explains the need for a new resource efficiency programme for Germany. And, non-recoverable waste must be disposed of safely, without harming the environment or human health. According to the waste management strategy, before being landfilled, organic waste needs to undergo mechanical-biological or thermal treatment to render it inert and to minimise the release of leachate and landfill gas. The landfilling of untreated organic waste has already been banned since mid-2005. It is reported that in 2017 there were 68 waste incineration plants operational in Germany, with a capacity of around 20 million tonnes, as well as 32 substitute fuel plants with a combustion capacity of around 5 million tonnes. In the same year 2017, 45 bio-mechanical waste treatment plants with a capacity of around 5 million tonnes treated some 4.5 million tonnes of waste, while only around 0.5 million tonnes of this volume ended up in landfills (BMU/Edited by Jaron and Kossmann, 2018, English version: FME 2018, page 13). The five-tier waste hierarchy defines the following order of priority action: first, prevention; second, preparation for reuse; third, recycling; fourth, other forms of recovery (particularly for energy); and fifth, disposal. In each case, priority is given to the most environmentally beneficial option. Alongside the environmental impacts, consideration must also be given to the technical options available, as well as the economic and social consequences. The "circular economy" in Germany therefore focuses consistently on waste prevention and recycling, without jeopardising established, high-quality, and environmentally-sound waste

[59] ProgRess II (Deutsches Ressourceneffizienzprogramm II); see on the programme: BMUB November 2016. It is a programme for the sustainable use and protection of natural resources. See the overview (in German) on the programme: https://www.bmu.de/themen/wirtschaft-produkte-ressourcen-tourismus/ressourceneffizienz/deutsches-ressourceneffizienzprogramm/

management processes. But more can be done and should be done in Germany to reach the stated objectives of waste prevention and to increase the rates of reuse, recycling and recovery. Up to 68 per cent of typical household waste is already recycled[60]. The household waste gives a successful example when the situation in 1990 is compared with the situation in 2015. In 1990, residual waste was by far dominating the recyclables (biowaste, packaging, glass, paper) in terms of million tonnes of household waste, but since 2004 the situation has changed quite favourably as recyclables are dominating residual waste and as both forms of waste are going down in volume. The new calculation method according to EU regulations will however force Germany to react by speeding up recycling efforts. The new EU Circular Economy Package (CEP) will request important adaptations also from the German side.[61] The situation is less satisfactory with construction and demolition waste, including non-hazardous road construction waste. Recovered are (in the year 2015) 180.9 million tonnes (mainly material recycling, and to a small extent energy recovery), but total disposal is 20.9 million tonnes (mainly landfill and to a small extent incineration and treatment). New instruments and methods to reach this goal in the context of the EU Circular Economy Package (CEP) are however not mentioned in the main documents (see BMU 2018). This would be necessary to continue with policies towards a forward-looking approach to waste management in Germany.

Implications for Waste Management Reforms in Nigeria: In Nigeria, recycling and recovery strategies are rarely mentioned as a holistic and systemic task; only informal and formal actors are mentioned with their respective activities. According to Oyebode (2018) it is fact that material recovery and recycling are becoming popular in many countries due to dwindling natural resources and increasing demand for raw materials by manufacturing industries. But such strategies are weak in Nigeria, despite of the potential for recycling, understood as a process that involves collecting, reprocessing and/or recovering certain waste materials (like glass, metal, plastics, and paper) to make new materials or products. In times of rapid urbanization such processes are increasingly important. But, also for agriculture development recycling/recovery

[60] The new calculation method under EU regulations will result in numerically lower recycling rates. Germany is committed to increasing recycling rates in the future.

[61] See on the implications of the new Circular Economy Package (CEP) of the EU for national legislation: http://ec.europa.eu/environment/waste/target_review.htm

are important strategies. It is emphasized by Oyebode (2018) that some recycled organic materials are rich in nutrients and can be used to improve soils. The conversion of waste materials into soil additive is called “composting”. Recycling and composting generate many environmental and economic benefits. So far, the potentials for industrial and agricultural development are not used at all. For example, recycling and composting create jobs and income, supply valuable raw material to industry, and produce soil-enhancing compost which is leading to higher agricultural productivity. All this is known in Nigeria, but concrete steps are not taken, and information and data on recycling/recovery measures and their effect in Nigeria are not available.

Concerning disposal, Oyebode (2018) argues that disposal activities are used to manage waste that cannot be prevented or recycled. Important is the way waste id disposed of. In Nigeria, the strategies of disposal are inadequate. One way to dispose of waste is to place it in properly designed, constructed and managed landfills where it is safely contained. But such landfills rarely exist in Nigeria. Another way to handle this waste is through combustion. Combustion is according to Oyebode (2018) the controlled burning of waste, which helps reduce its volume. Again, the situation in this regard is not favourable in Nigeria. In case the technology is available, properly designed, constructed, and managed the combustion facilities can generate energy; combustion facilities also produce steam as a by-product that can be used to generate energy. It is proposed to use the business model of public private partnership to advance in this direction.

To come forth with such an approach in Nigeria, it is proposed by Oyebode (2018) to aim at an Integrated Solid Waste Management (ISWM) process which is understood as a comprehensive waste prevention, recycling, composting, and disposal programme. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. The ISWM process involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. This means that conventional blueprints for action are not appropriate; the local conditions and needs should be incorporated in all stages. The major ISWM activities are,

according to Oyebode (2018), waste prevention by producers and consumers, recycling and composting by informal and formal sector actors in the waste industry, and combustion and disposal in properly designed, constructed, and managed landfills. But all these activities require careful and sustainable processes of planning, financing, collection, and transport. So far, all these steps are underdeveloped in Nigeria; the whole waste industry value chain needs improvement, innovation, strengthening, and integration. At the federal level and at state levels the regulatory framework is not really advancing. It is referred to draft documents at the federal level, the state level and the municipal level. It is argued by Uchendu (2016) that progress in regard of regulatory frameworks can only be achieved if laws and policy documents on waste refer to all government levels and do include strongly the issue of financing waste management activities so that responsibilities are made clear along the waste industry value chain. Also, other actors like the policymakers on the National Policy on Municipal and Agricultural Waste (MAW) of Nigeria, the public and private operational waste industry institutions, and the Waste Management Society of Nigeria (WAMASON)[62] should play their roles. Mohammed (2018) refers to the need to coordinate waste management and environmental sanitation strategies as closely as possible to get control of environmental health risks in the country. Environmental sanitation in Nigeria is very strongly affected by all forms of waste and by the waste management strategies pursued. Also waste management strategies and agricultural development strategies need more coordination (see the policy document on "Agricultural Policy For Nigeria" of the FMAWRRD/Federal Ministry of Agriculture, Water Resources And Rural Development (Federal Ministry of Agriculture and Rural Development/FMARD), Abuja, n. d.).[63] Nigeria could benefit from learning about the process of elaborating and presenting an annual waste management strategy report in Germany (see BMU 2018, German and English versions).

8.3 Commercial Waste in Germany

Each year in Germany, large quantities of commercial waste are generated by more than 3.6 million businesses (see below: BMU 2018). Although a large portion of this is already collected separately and recycled, nevertheless some 6 million tonnes of mixed municipal waste of

[62] See on the functions and activities of WAMASON: https://www.wamason.org/
[63] See the Reprint of the document by FMAWRRD, now FMARD: extwprlegs1.fao.org/docs/pdf/nig149296.pdf

commercial origin (including mixed packaging) are generated each year.[64] Figure 4 shows how problematic the commercial waste can be for waste management in Germany.

Figure 4: Commercial Waste in Germany

Source: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste

In Germany, such wastes can be collected a) separately from household wastes (in swap containers) or b) together with household wastes as so called "business waste" (in containers that are emptied).[65] The Gewerbeabfallverordnung (GewAbfV) regulation governs the handling of these wastes and lays down the requirements that must be met for high-quality recycling of these

[64] UBA/Federal Environment Office reports in 29/4/2013 about Commercial Municipal Waste (CMW): "No separate statistics are available for separately collected commercial waste. According to the Abfallentsorgung statistics issued by the Federal Statistical Office (Statistisches Bundesamt), in 2010 around 3.45 million tons of mixed commercial municipal waste, three million tons of mixed construction and demolition waste, and 2.35 million tons of mixed packaging waste were trucked to waste processing facilities."; see: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste, and SBA 2018, 2016.

[65] See on the respective modalities: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste

wastes.[66] In recent years, only around 45 per cent of this mixed waste was pre-treated in sorting facilities; the remaining 55 per cent or so was used directly for energy recovery.[67] Only around 0.4 million tonnes of the 2.6 million tonnes of pre-treated mixed waste was segregated and recycled. In other words, just 7 per cent from a total of 6 million tonnes of mixed municipal waste of commercial origin was recovered for materials. This prompted, due to discussions and researches since 2012 in Germany[68], the entry into force of the new Commercial Wastes Ordinance on 1 August 2017.[69] The Ordinance introduced a strict cascade of obligations, spearheaded by the mandatory separate collection of paper, board and cardboard, glass, plastics, metals, wood, textiles, bio-waste and other production-specific waste fractions. Any mixed waste remaining after segregation must be pre-treated[70]. The results for resource conservation in Germany based on the new regulations and on new technologies may be huge, as ultimately there is potential for multiplying the volume of recycled materials up to six times.[71] See the figure

[66] See on the new commercial waste regulations (Gewerbeabfallverordnung) since 2017 and 2019: https://www.bmu.de/gesetz/verordnung-ueber-die-entsorgung-von-gewerblichen-siedlungsabfaellen-und-von-bestimmten-bau-und-abbruc/

[67] The UBA/Federal Environment Office also reports: "Disposal of mixed commercial municipal waste has always been and continues to be a matter of debate in the field of waste management, primarily due to the lack of data and knowledge concerning these quantity and resource relevant wastes. There appears to be room for improvement in the various disposal techniques, from an environmental protection and resource conservation standpoint."; see: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste. But the results in terms of recycling are meagre despite of the huge resources potential inherent in municipal waste as emphasized by the UBA/Federal Environment Office: "But because only 43 percent of Germany's 6.4 million tons of municipal waste is currently trucked to mechanical pretreatment facilities, where the waste is often sorted in the "simplest fashion," only 16.5 percent of the recyclable elements are actually recovered from such waste, via the sorting process."; see: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste. This is a situation which is not acceptable at the high technological level of Germany.

[68] Mainly supported by the German UBA/Umweltbundesamt/Federal Environment Office; see specifically: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste.

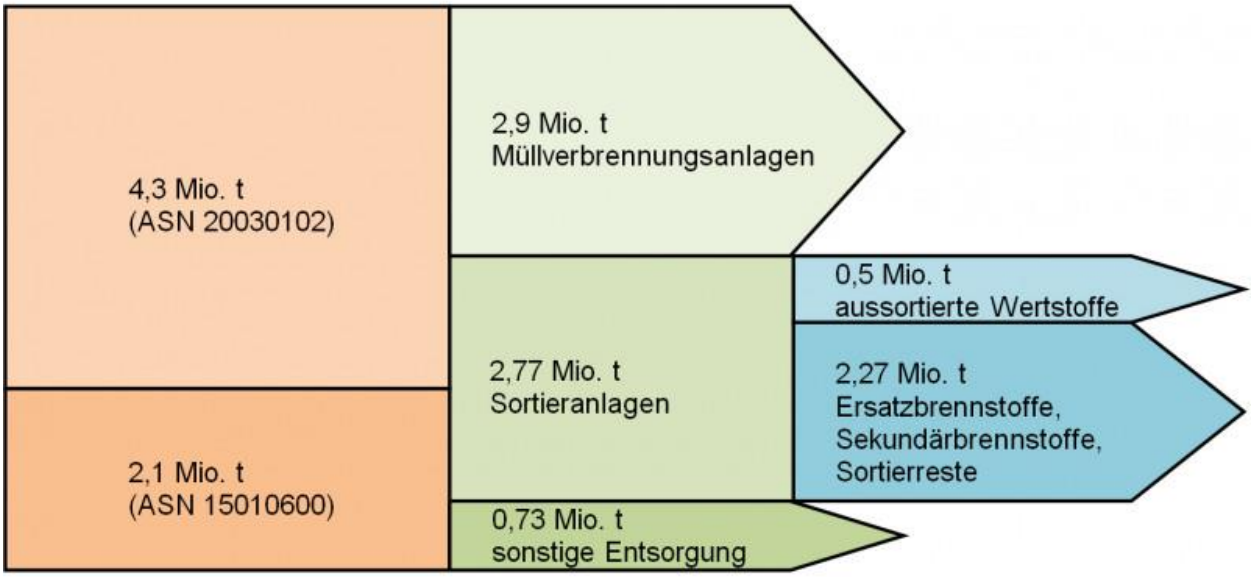
[69] The Commercial Wastes Ordinance (CWO) may have great impact on organizing commercial waste through a) qualified commercial waste officers and b) appropriate commercial waste documentation; see: https://www.interseroh.de/en/services/consulting/waste-management-officer-and-commercial-waste-ordinance/. In this context the EU Commission argues with Germany about the openness of the waste sector to foreign waste management firms which are applying for contracts; see: ec.europa.eu/DocsRoom/documents/21487/attachments/2/.../pdf.

[70] January 1, 2019 will see the introduction of mandatory recycling rates of 30 per cent, together with other special requirements for pre-treatment plants. The current equal ranking afforded to material and energy recycling for commercial waste will be abolished; it will be replaced by the five-tier waste hierarchy making it applicable for this important substance flow.

[71] See the UBA/Federal Statistical Office on this issue: "In view of the estimated 460,000 tons of recyclable materials that are recovered via the sorting process and the actual amount of recyclable materials contained in

below for the "disposal paths" of commercial settlement waste mixtures. The figure 5 below shows how weak the recycling process still is in Germany; but, also the environmental aspects of generating higher recycling rates need to be considered, what was the purpose of various research projects since 2012.

Figure 5: Disposal Paths of Commercial Settlement Waste Mixtures



Source : https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste

Note on the Abbreviation: ASN stands for „Abfallschlüsselnummer", and means that ASN is classifying certain types of waste, according to all classified forms of waste (according to the Abfallverzeichnis-Verordnung).

There are many arguments to recycle directly the commercial waste instead of throwing away. This also refers to medical waste, universal waste, hazardous waste, etc. and requests the spread

waste, it is safe to assume that anywhere from 1.1 to 3.2 million more tons of recyclable materials could be recovered through waste sorting."; see: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/commercial-municipal-waste.

of a new entrepreneurial spirit. Companies can assist in this task and can show the many advantages of a pro-active behaviour on the side of the businesses.[72]

Implications for Waste Management Reforms in Nigeria: In Nigeria, commercial waste is not clearly separated from household waste, and the various types of non-household waste are not identified properly. Beside of municipal waste there is industrial waste, agricultural waste, construction and demolition waste, and commercial and institutional waste. A database is needed for these types of waste. Also, hazardous waste (related to these forms of waste mentioned above) should be identified. It is necessary to have classify these forms of waste and to establish a database first at state level and then for the federation. The database should be specific also on the actors which are responsible for the waste accumulation (large firms and formal sectors, small firms and informal sectors, subsistence and modern farmers/farms, health personnel, doctors and pharmacies, etc.). Nigeria has large waste management and recycling firms which could care for the recycling of all these forms of waste; these firms should also aim at providing a healthy disposal of hazardous waste. But there is a lack of competition among firms and a lack of transparency on contracts between public authorities and private firms on waste management.[73] It was emphasized (by Adewuyi/Odesola 2016) that minimizing construction waste depends basically on training and human resources development in construction companies. Training and retraining towards material handling, storage and transportation can have beneficial effects on overall waste management. Looking at Germany and Nigeria in comparison, we see that commercial and industrial waste management could be improved by stricter regulation, by more training and retraining in waste management companies, and by establishing more transparency towards waste management contracts between public authorities and private companies.

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[72] See on the role of pro-active recycling strategies of private and municipal firms: http://www.bwaste.com/why-recycling-your-business-waste-is-important/; see also: https://www.signalwaste.com.au/Adopting-Proper-Waste-Management-Techniques-Can-Be-Beneficial-for-Commercial-Establishments-bgp4115.html.

[73] See on the large Nigerian waste management services and waste recycling companies: https://www.finelib.com/business/energy/waste-management, and: https://www.finelib.com/business/energy/recycling, and: https://www.environmental-expert.com/waste-recycling/companies/location-nigeria.

8.4 Waste Graphic Paper and Packaging Waste in Germany

At the initiative of the German Environment Ministry (BMU), on September 26, 1994 AGRAPA (Arbeitsgemeinschaft Graphische Papiere)[74], an alliance of associations and organisations from the paper manufacturing industry, the paper importers, the paper wholesalers, and the printing industry and publishers, issued a voluntary declaration pledging to gradually increase the material recovery of waste graphic paper to 60 per cent by the year 2000 (see BMU 2018/FME 2018, page 18). Graphic paper refers to print products and paper used in offices and administration. These efforts proved so successful that in September 2001, AGRAPA upgraded its voluntary commitment of 1994, pledging to permanently maintain the recycling rate at 80 per cent (+/- 3 per cent).[75] However, for some years this promise could not be met, although the paper industry failed the target it has set by only small amounts in 1998, 2004 and 2012.[76] But the paper industry has more or less kept its promise, although the figures differ in the presented graphs, depending on the years chosen.[77] This is a very welcome development for the environment, and it is considered ass an excellent example of an industry taking responsibility for the waste management of its products. At the same time, it underpins the importance of waste paper recycling in the German paper industry, and obviously makes a significant contribution towards relieving pressures on the environment. Despite of the importance of this voluntary declaration, it needs to be acknowledged that E-waste is now replacing the use of graphic paper, as also the catalogues of shops and the pamphlets of organizations have a declining importance.

Reality is however different as the recycling rate (recycling to consumption of waste graphic paper) is fluctuating considerably and recently on the increase. The recycling rate has reached

[74] See on AGRAPA and the voluntary declaration of 1994: http://www.gesparec.de/geschaeftsfelder/agrapa/agrapa.html?L=0

[75] Now, AGRAPA had been replaced by the Gesellschaft für Papier-Recycling (GesPaRec) with the mandate to propagate better recycling conditions in the whole industry, by incorporating the Arbeitsgemeinschaft Graphische Papiere (AGRAPA, the European Recovered Paper Information System (ERPIS), and the Qualitätsmanagement Altpapier (QMAP); see: http://www.gesparec.de/.

[76] See: https://www.bmu.de/en/topics/water-waste-soil/waste-management/waste-management-statistics/waste-paper/recycling-of-waste-graphic-paper/.

[77] See: BMU 2018/FME 2018, p. 18, and: https://www.bmu.de/en/topics/water-waste-soil/waste-management/waste-management-statistics/waste-paper/recycling-of-waste-graphic-paper/. In BMU 2018/FME 2018, p. 18 we find even a spectacular recycling rate for 2009 of 97%.

88% in 2010 and has declined to 80% in 2012, again rising to 82.2% in 2016.[78] And, consumption of waste graphic paper is declining rather slowly (despite of the E-Paperless Offices Movement in so many public and private offices). Because of the ecological advantages of using products from waste paper instead of products from fresh fibres, the Blue Angel eco-label was awarded to recycled paper products (see figure 6 on waste graphic paper for recycling).

Figure 6: Waste Graphic Paper for Recycling

Source: BMU 2018, English Version: FME 2018, page 18

Packaging waste is of increasing importance and ecological relevance despite of some recovery successes in Germany. Packaging is part of daily life in Germany and it is increasing in importance because of the growth of internet trading.[79] Its main constituents are glass,

[78] See on the data: https://www.bmu.de/en/topics/water-waste-soil/waste-management/waste-management-statistics/waste-paper/recycling-of-waste-graphic-paper/

[79] In future, the online retailers have to register their packaging activities; see on the New Packaging Act in Germany: https://ixtenso.com/logistics/new-packaging-act-in-germany-online-retailers-must-register.html. It is requested for these online retailers and mail order companies to register: "Online retailers and mail order companies that have not licensed their packaging yet should do so no later than the beginning of 2019. So-called first-time producers of packaging ("Erstinverkehrbringer") are legally obligated to participate in a dual system and pay license fees. The new Packaging Act (Verpackungsgesetz) ensures transparency but can also result in fines and

aluminium, tin plate, plastic, paper, cardboard and wood, all of which are valuable (secondary) raw materials. The use of plastic, paper and cardboard is increasing for these new forms of trading. Registering to a Central Office is requested through the New Packaging Act.[80] Reusing or recovering these materials helps to conserve natural resources, to save energy, and to reduce emissions of greenhouse gases. The separate collection of household packaging waste introduced by the Packaging Ordinance enjoys a high level of support among the German public. Overall in Germany, around 97 per cent of all packaging waste was recycled in 2015 what is a huge jump since 1991; but the recovery rates of glass, aluminium and tin plates are still somewhat smaller relative to plastics, paper board and liquid packaging board[81]. But waste prevention is not really part of the system. Online trading and packaging through online traders are energy- and transport-intensive services; the "sending back and reclaiming new delivery" attitude adds to the negative effects on the environment. It may be relevant to think about new price and tax mechanisms in Germany to impact on the increasing volumes of internet trading, but this overlaps with more general issues of demands for taxing internet and internet trading companies' profits and turnover on a global scale.

Implications for Waste Management Reforms in Nigeria: In Nigeria, the situation is quite different, but waste management needs to direct effort to waste graphic paper and to packaging waste as well. Recent evidence shows that in Abuja the main principles of solid waste management need to be brought to work before specific separation and recycling efforts can succeed, such as for waste graphic paper and packaging waste (see Kadafa 2017). Also, the study for waste management in Abuja shows that different parts of the Federal Capital Territory (FCT) of Abuja have different attitudes of residents towards minimization of waste, collection, recycling and recovering. Pressing need is to prevent further health hazards because of the poor

prohibition in sales for non-compliance." See also the following description of the New Packaging Act: https://www.gruener-punkt.de/en/services/packaging/german-packaging-act.html.

[80] The packaging consumption data need to be registered for getting licenses; this refers to the materials that are subject to licensing such as boxes, cartons and envelopes, but also includes packaging components such as labels, foils, padding and adhesive materials. See: https://ixtenso.com/logistics/new-packaging-act-in-germany-online-retailers-must-register.html.

[81] See: BMU 2018/FME 2018, pages 20-21. On average, each German citizen already consigns almost 30 kilograms of waste per year to yellow sacks and yellow bins for separate collection from the rest of their household waste. Glass and paper packaging is also collected separately. As of 1 January 2019, the Packaging Ordinance will be replaced by the Packaging Act.

record of solid waste management. Waste graphic paper and all forms and substances of packaging waste are of concern in Nigeria, and Nigeria has a great number of waste paper professionals, but it is not clear how recycling works.[82] Packaging waste is collected and recycled to some extent by the informal sector, but progress on recycling depends on progressive attitudes towards the informal sector and on a better cooperation with formal businesses and the public authorities (see Nzeadibe/Iwuoha 2008, and more up-to-date reports on the activities of the informal sector). The formal sector is also active. It is reported that "The Food and Beverage Recycling Alliance (FBRA) - a coalition comprising Coca-Cola Nigeria Ltd., Nigerian Bottling Company, Nestle Nigeria PLC, Seven Up Bottling company and Nigerian Breweries Plc, have signed a Memorandum of Understanding (MoU) with the Lagos State Government, through the Ministry of Transportation, to rid the state's waterways of plastic and packaging waste."[83] It seems that the public-private partnership is very demanding on the public resources of Lagos State, but some successes of the initiative (for transport, job creation and the environment) are already reported.

Nigeria is more concerned now with e-waste as used, outdated and energy-intensive electronic ICT equipment is flooding the market. The analysis on e-waste (by Akuru/Okoro 2010, and similarly in many other reports) gives evidence that the rapid growth of e-waste can be used for recycling (of various metals and materials) and so e-waste can be the basis for domestic industries and for energy generation. But all depends on pro-active public and private sector industrial and human resource development policies. Without clear policy frameworks it will not be possible to convince the private sector to establish paper recycling facilities in Nigeria.[84]

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[82] See on the waste paper businesses in Nigeria: https://www.vconnect.com/nigeria/list-of-waste-paper-vendors-search_p16250?page=1

[83] See the story about this Pact (from 1 August 2018 in The Guardian): https://allafrica.com/stories/201808010261.html. It is reported: "The pact is a three-year partnership between Lagos State and the FBRA to clean-up and prevent waste pollution from plastics and other food and beverage packaging, on Lagos State's inland waterways." Also, it is reported: "While the FBRA will provide funding for equipment, gears and personnel training, the Lagos State government will be responsible for structural civil works, managing execution, personnel, waste sorting centres and enforcement. FBRA and Lagos State government will jointly fund public awareness campaigns and advocacy on appropriate packaging waste disposal systems."

[84] There are plans/feasibility studies for paper recycling facilities, but not enough investments yet; see: https://foramfera.com/marketresearchreports/manufacturing-market-research-reports/waste-paper-recycling-in-nigeria-jumbo-rolls-production-the-pre-feasibility-report/

8.5 Bio-waste, Marketing of Compost and Digestate and Sewage Sludge in Germany

Bio-waste constitutes 30-40 per cent of municipal waste in Germany according to the BMU/Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.[85] The share of humus in the soil can be increased and mineral fertilisers can be replaced, thereby leading to a sustainable use of resources. The separated collection of biowaste also reduces the volume of residual waste, thereby facilitating the processing of this waste. Because of the collection in separate bins, the compost from this waste contains 95% less contaminants than compost generated from mixed waste. When bins are properly handled, then health risks will not occur. In 2015, some 13.85 million tonnes of biodegradable waste (primarily waste from bio-bins, biodegradable garden and park waste, market waste and other biodegradable waste from a variety of sources) were treated in composting and digestion plants / biogas installations (see BMU 2018/FME 2018, pp. 22-27). Of this, around 4.57 million tonnes were collected separately via bio-bins, together with around 5.1 million tonnes of garden and park waste, corresponding to an average collection rate of 118 kilograms per inhabitant, per year. According to the latest provisional figures from the German Federal Statistical Office (FSO), in 2016 the volume of bio-waste collected separately from private households rose by more than 500,000 tonnes (an increase of 6 kilograms per inhabitant) compared with 2015 (FSO/Federal Statistical Office, 2017). Some 4.83 million tonnes were collected separately in 2016 from bio-bins, together with around 5.35 million tonnes of garden and park waste (totalling 10.18 million tonnes, or 123 kilograms per inhabitant). In 2015, from the total volume of bio-waste, 7.37 million tonnes were consigned to 868 composting facilities, and 6.48 million tonnes to 1,392 digestion plants (including combined digestion and composting facilities). This was used to produce around 3.96 million tonnes of compost and 4.09 million tonnes of fermentation substrate for use in various sectors as fertilisers or soil additives[86]. Compost is used for agriculture and forestry (62.3% in 2015), for landscaping (17.1%), and for private households (20.6%). Digestate (Gärreste), being residuals from the production of biogas facilities, are used mainly for agriculture and forestry

[85] See: https://www.bmu.de/en/topics/water-waste-soil/waste-management/types-of-waste-waste-flows/organic-waste/

[86] Bio-waste also makes a growing contribution to energy generation. It can be used to generate power and heat or processed and fed into the natural gas grid. The Renewable Energy Sources Act (EEG) supports operators of existing composting facilities wishing to add a fermentation phase. Combined processes of this kind generate both usable biogas and valuable compost, which can be used as a fertiliser and as a soil improver.

(97.1% in 2015) and the rest for landscaping. Mainly ecological, resource recovery and economic reasons lead to the intensive collection and processing of bio-waste. Biodegradable waste which is located in landfills would have serious ecological repercussions through the generation of the greenhouse gas methane. Separate collection is a must to generate high-quality bio-waste (see Schüch et al. 2016), especially for environmental and for resource conservation reasons. Operators of bio-waste treatment plants in Germany have a great role to reduce climate-relevant emissions. Even in Germany more awareness in the whole bio-waste value chain is needed. Also, a further improvement of the separate collection process is requested (Schüch et al. 2016). German Biowaste and Biogas companies have developed technologies which are sold successfully on the world market, like in China.[87] Biowaste adds a valuable contribution to energy generation in Germany. By using biowaste in this way it is possible to generate power and heat. Biogas can be used for processing purposes and can be fed into the natural gas grid. The Renewable Energy Sources Act (EEG/Erneuerbare-Energien-Gesetz) of Germany supports operators of existing composting facilities who are wishing to add a fermentation phase.[88] Combined processes of this kind are generating both usable biogas and valuable compost, which can be used as a fertilizer and as a soil improver.

Sewage sludge from public sewage treatment plants (around 1.8 million tonnes dry weight) contains a range of plant nutrients, particularly phosphorus. In the municipal treatment plants, the thermal treatment ratio has increased from 31.5% in 2004 to 54% in 2011.[89] Because of the contained plant nutrients, sewage sludge is also used as a fertiliser in agriculture (around 24 per cent in 2016) and in landscaping (around 10 per cent in 2016). Some 65 per cent of sewage sludge is incinerated, leading to the loss of valuable phosphorus.[90] Mindful of the limited phosphorus reserves available worldwide, the German Government supports the recovery of

[87] See as an example: http://www.germanbiogas.com/pubgrp/cover771e.html?id=750&t=1847

[88] The EEG 2017 brought some changes to the Act; see the document reflecting the changes up to July 2017: https://www.bmwi.de/.../renewable-energy-sources-act-2017.pdf%3F__blob%3Dpublica.... For country - comparative purposes see: http://www.lse.ac.uk/GranthamInstitute/law/renewable-energy-sources-act-eeg-latest-version-eeg-2017/. See also on EEG 2017: https://www.gesetze-im-internet.de/eeg_2014/

[89] UBA gives another figure for the tons of sewage sludge (around 2 million tons); see: https://www.umweltbundesamt.de/en/publikationen/sewage-sludge-management-in-germany

[90] See on the BMU/UBA policies on sewage sludge the report UBA 2015/2013; and for download of the PDF: https://www.umweltbundesamt.de/.../sewage_sludge_managemen...

phosphates from sewage sludge and domestic waste water to supplement the current practice of applying sewage sludge directly to the soil[91]. So far, the rate of sewage sludge used in agriculture has declined continually from 41.9% in 1997 to 24% in 2016 (BMU 2018/FME 2018, page 27).

Implications for Waste Management Reforms in Nigeria: In Nigeria, biowaste is put mostly to (illegal and legal) landfills, thereby loosing valuable resources, such as fertilizer, risking health conditions in urban areas, semi-urban areas and slum areas, and damaging the environment via methane emissions. The organic wastes have various sources in Nigeria; livestock wastes (cattle excreta, sheep and goat excreta, pig excreta, poultry excreta; and abattoir waste) are important, but also human excreta, crop residue, and municipal solid waste (MSW). According to standard measurements, Nigeria generates about 542.5 million tons of the above mentioned selected organic waste per annum. This will yield about 25.53 billion m^3 of biogas (about 169,541.66 MWh) and 88.19 million tons of bio-fertilizer per annum. Both uses of organic waste have a combined estimated value of about N 4.54trillion ($ 29.29 billion). This potential biogas yield could completely displace the use of kerosene and coal for domestic cooking, and it could reduce the consumption of wood fuel by 66%. An effective biogas programme in Nigeria will also remarkably reduce environmental and public health concerns, deforestation, and greenhouse gas emissions. Together with biofertilizer, a valuable addition to the economic development of agriculture, industry, transport, and consumption will be made (see on the data: Ngumah et al. 2013). But this is the potential of biofuel and biofertilizer; the problem is the transformation into actual uses. Most of the biowaste is in landfills and creates environmental and health problems through livestock-raising, bad sanitation for human beings, unused crop waste, and lack of organized municipal waste collection, processing and disposal. Only 20-30% of solid waste is collected, out of 32 million tonnes annually which are generated.[92] The rates for the other organic wastes are even lower (livestock waste, crop residue, and human waste). Nigeria has

[91] However, the German Government and the Federal States (Länder) have jointly resolved to scale down soil-related sewage sludge use in agriculture over the next 15 years. The German Environment Ministry has updated the Sewage Sludge Ordinance of 1992, and included provisions on increasing the recovery of phosphorus, ultimately with a view to nationwide enforcement. The Ordinance entered into force on 3 October 2017.

[92] See: https://www.bioenergyconsult.com/solid-waste-nigeria/

only few composting and recycling plants, like in Ekiti State[93] and in Kano State. Also, at village level composting is becoming more popular, based on appropriate technologies. At markets various types of waste are mixed, so that the environment conditions and the health situation are at risk. Restoring order at marketplaces is important for integrated solid waste management (ISWM). Sorting of biodegradables and non-biodegradables is seen as the basis for using the content of raw materials of both sources for valuable products from waste. A solution may be the launching of organo-mineral fertilizer plants, such as those planned and projected by the University of Ibadan, the Sustainable Ibadan Project, and the Ibadan Waste Management Authority under the frame of "Turning Waste to Wealth Projects" (see Sridhar/Hammed 2014 for various locally developed technologies to process biodegradables and non-biodegradables). It may be important to turn from pilot projects to nation-wide treatment of waste. It is also important to learn from other developing and emerging countries with similar problems resulting from high population density. Studies for Brazil, to take an example, show that household food waste can be used as a substitute for cattle manure in densely populated areas, such as was investigated in tests for fertilizing cherry tomato plants (see Da Costa Ferreira et al. 2018). Nigeria with its densely populated urban areas, being surrounded by agricultural areas, can also think about fertilizing nearby agricultural fields through compost from household food waste instead of using cattle manure. Getting from tests to pilot projects and then to demonstration plants is important, but this not enough; it is necessary to move to a broad application of such technologies to use biowaste. This is a chance to turn "waste into wealth" in countries like Nigeria. All this however depends on a coherent biowaste waste management programme which is really based on an Integrated and Comprehensive "Waste to Wealth" Strategy.

8.6 Waste from Electrical and Electronic Equipment, Waste Batteries, and treating all forms of E-Waste in Germany

Between 2006 and 2015, some 7.2 million tonnes of waste electrical and electronic equipment were collected and treated in Germany (see BMU 2018/FME 2018). The situation is not satisfactory in Germany. While the specific volumes which are collected from private households are stagnating (in terms of kilograms per inhabitant), the recovery rates and the

[93] Also in Ekiti State the fertilizer plants are demonstration projects; see: https://waste-management-world.com/a/composting-facilities-set-for-ekiti-state-nigeria.

recycling rates are rather declining since 2012 (see BMU 2018/FME 2018, page 29). The statistics show that Germany has by far exceeded the EU's prescribed recovery and recycling quotas for waste electrical and electronic equipment every year to date. While annual collection targets were previously based on the number of inhabitants, from 2016 onwards, a new collection/return quota for waste equipment from private households and commerce of 45 per cent of all equipment placed on the market during the preceding three years came into force in all EU Member States. Against this background, and given Germany's commitment for boosting resource efficiency, it is important to improve the quality and quantity of collection still further in future. Electrical and electronic waste often contain toxic substances, and therefore this waste needs to be disposed of properly; otherwise pollution and health problems will follow. It is for this reason that electrical and electronic waste is collected separately not only in Germany, but in all EU countries. In 2010 nearly 780,000 tons of electrical and electronic waste were collected in Germany, and 723,000 of it from households. This is the equivalent of 8.8 kilograms (per capita and year). The remaining volume of 54,000 tons came from businesses, what is a relatively small amount.[94] The Waste Electrical and Electronic Equipment (WEEE) Directive of the EU was adopted in 2003 to institutionalize harmonized European regulations for electrical and electronic waste. This directive was transposed into German law in 2005 via the Elektro- und Elektronikgeräte-Gesetz (ElektroG). An amended version of the directive, which is known as WEEE II, was enacted in July 2012. This directive was also transposed into German law via an amended version of the ElektroG.[95] In Germany, a system of "divided product responsibility" was instituted for electrical and electronic waste disposal operations, meaning that the public sector, the manufacturers, the retailers, and the consumers have a role to play in waste management by law.[96] To address the two key problems (increasing volumes of WEEE and increasing danger through hazardous EEE waste) two pieces of legislation had to be put in place: first, the Directive on waste electrical and electronic equipment (WEEE Directive) and second, the Directive on the Restriction of the use of certain Hazardous Substances in electrical and

[94] See data from UBA/Umweltbundesamt: https://www.umweltbundesamt.de/en/topics/waste-resources/product-stewardship-waste-management/electrical-electronic-waste#textpart-1

[95] See on WEEE II and further developments at the EU level: http://ec.europa.eu/environment/waste/weee/index_en.htm

[96] See on this issue: https://www.umweltbundesamt.de/en/topics/waste-resources/product-stewardship-waste-management/electrical-electronic-waste#textpart-1

electronic equipment (RoHS Directive).[97] Figure 7 gives an impression of the urgent need to address the problems of this type of waste in Germany.

Figure 7: Electrical and Electronic Waste in Germany

Source: https://www.umweltbundesamt.de/en/topics/waste-resources/product-stewardship-waste-management/electrical-electronic-waste#textpart-1

Since the European Union Battery Directive (EUBD) entered into force in 2006 in Germany, the separate collection and recovery of batteries has been mandatory throughout all EU Member States.[98] A collection rate of 40 per cent has applied in all EU Member States since 2014; in 2016, this rate was raised to 45 per cent of the batteries which were placed on the market during the preceding three years. Each year, more than 40,000 tonnes of portable batteries and accumulators enter the German market.[99] According to the Batteries Law of Germany (BattG) manufacturers and importers are requested to register the volumes of batteries and accumulators

[97] See on the two major problems associated with WEEE: http://ec.europa.eu/environment/waste/weee/index_en.htm, and: https://www.umweltbundesamt.de/en/topics/waste-resources/product-stewardship-waste-management/electrical-electronic-waste#textpart-1

[98] See on the EU policy and legislation: http://ec.europa.eu/environment/waste/batteries/index.htm

[99] See: https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/batterien#textpart-1

their supplies to the market in electronic form.[100] The use of the register is free of charge; part of the information of the Register is made public to inform about the duties and responsibilities of the manufacturers and suppliers to take back and to dispose of the batteries and accumulators after use. Figures about the collection rates of portable batteries show divergent trends, although the overall rate records a slight increase (see BMU 2018/FME 2018, page 31). Although the Batteries Act commits end users to collect all waste batteries separately, barely more than half of this volume ends up in the special containers which are provided in shops and at public collection points. Vehicle and industrial batteries continue to be collected and recovered. Valuable secondary raw materials such as zinc, steel, ferromanganese, lead, cadmium and plastic can be recovered from waste batteries and reused (see figure 8 on the dimension of the problem).

Figure 8: Waste Batteries in Germany

Source: https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/batterien

[100] See: https://www.umweltbundesamt.de/themen/abfall-ressourcen/produktverantwortung-in-der-abfallwirtschaft/batterien#textpart-1

Implications for Waste Management Reforms in Nigeria: For Nigeria, this form of waste is danger and opportunity at the same time. Some policies of the EU and of Germany may have relevance for the 36 States of Nigeria and for the Federation of Nigeria, such as the harmonization policies of the EU in terms of definitions and classifications and the policies of Germany towards the registering of the market presence of the manufacturers and the suppliers. The discussion in Nigeria about Waste EEE (or E-Waste) goes on since 2010, and the dangers for the health situation and the environmental hazards for humans, livestock and the ecology are emphasized. But also, the alternatives are discussed of how to use and to manage properly the E-Waste (see: Adediran/Abdulkarim 2012). There are many dangerous components listed for Waste EEE and E-Waste, and the serious effects on the health of humans of mercury, lead, chromium, BFR (brominated flame retardant), and Cadmium are well established. Resource recovery from Waste EEE/E-Waste is also important for Nigeria but avoiding health threats to the people has priority as Waste EEE/E-Waste is brought simply to illegal and unprepared landfills. Nigeria is highly interested to benefit from international control systems of Waste EEE/E-Waste, based primarily on the Basle Convention and on other international initiatives. However, Nigeria's own initiatives are however not adequate and not serious enough, despite of the many institutions which could act. to solve the problem. It should be mentioned that Nigeria has a Federal Environmental Protection Agency (FEPA), a National Environmental Standards and Regulations Enforcement Agency (NESREA), a National Emergency Management Agency (NEMA), a National Space Research and Development Agency (NASRDA), and a Nigeria Customs Service (NCS) to mention just these few responsible but inactive institutions. There is no legislation to control E-Waste, there is no control of imported used electronic equipment, there is no public awareness of the inherent dangers of E-Waste, there are no E-Waste recycling facilities in Nigeria, and there is a gap in CSR (Corporate Social Responsibility) on the side of industries regarding E-Waste. Only the informal sector businesses and workers are doing something (sorting, recovering, recycling), but they are working mostly without knowledge and information about the threats to humans, to livestock and to the ecology. It is necessary to involve all the eight groups of stakeholders (manufacturers, recyclers, resellers, aggregators, regulators, collectors, end-users, suppliers) to control the stream of E-Waste, and to care for

health, ecology, and resource efficiency.[101] Reduce, Reuse, Recycle (3R) strategies are increasingly relevant for Nigeria to industrialize the country, to care for ecology and natural resources, and to provide a healthy environment.

Nigeria is burdened by Waste Electrical and Electronic Equipment (WEEE), and its 1.1 million tonnes of e-waste every year stem from both local and imported EEE. Importation of EEE is rapidly increasing: in 2015, Nigeria saw 56,000 tonnes of imported e-waste, and in 2017 this figure increased to 288,000 tonnes so that imports are now more than four times higher than two years earlier.[102] In 2012, half of the EEE which was imported into the country was second-hand. There is increasing relevance to control the importation process so that the various uses of the imports are made clear. Although the intended registration of such imports is necessary, also all market supplies of EEE in Nigeria need some form of registration. In this regard Nigeria can learn from the EU/EU member states procedures. Nigeria is establishing an Extended Producer Responsibility (EPR) policy to get control of the process; this process should have started in 2016, but it is not yet clear what works. But, Hinckley Recycling, an e-waste processing company that started out as a service centre for the global IT firm Hewlett Packard, was licensed by the NESREA and the Lagos State Environmental Agency in 2017.[103] The capacity is 30,000 tons per year so that a great number of such processing companies would be necessary (see figure 9 on recycling work at Hinckley Recycling).

[101] See the essay by Adediran/Abdulkarim 2012: https://www.researchgate.net/publication/266501245_CHALLENGES_OF_ELECTRONIC_WASTE_MANAGEMENT_IN_NIGERIA

[102] See on the trade data and the related policy issues: https://resource.co/article/nigerias-e-waste-mountain-13017

[103] See: https://resource.co/article/nigerias-e-waste-mountain-13017; see also about the story: https://www.dailytrust.com.ng/nigeria-gets-first-e-waste-recycling-facility.html

Figure 9: Staff at Hinckley Recycling in Lagos repairing WEEE.

Source: https://resource.co/article/nigerias-e-waste-mountain-13017

Hazardous components are shipped through the company to other countries. There is however reluctance to involve the formal sector companies, from the side of the consumers and from the side of the informal sector operators.[104] A cooperation of such formal sector companies and the informal sector may have advantages, as the informal sector has a great pool of knowledgeable workers and has the capacity to prepare refurbished electronic devices for foreign markets. Formal sector companies can help in eliminating/disposing of hazardous components. Imports of E-Waste add to the problem of hazardous components. Figures on illegal imports of E-Waste are outdated.[105] It is estimated that in the year 2010 not less than 100,000 tonnes of E-Waste were imported illegally (see: BCCC/Basle Convention Coordinating Centre, Nigeria/UNEP/Eidgenössische Materialprüfungs- und Forschungsanstalt/EMPA 2012, and BCCC/UNU-VIE SCYCLE 2017).[106] Every year approximately 1.1 Mio. tonnes of EEE become

[104] See: https://resource.co/article/nigerias-e-waste-mountain-13017

[105] There is some role played by the institution "Environmental Justice Atlas" (EJA), established as an NGO; see: https://ejatlas.org/conflict/e-waste

[106] Obviously, there is a great role for US to cooperate with Nigeria and other countries to eliminate black market operations of E-Waste; see Terada 2012. Most important, the exemption of E-Waste in the US from the Resource Conservation and Recovery Act and the refusal of the US to ratify the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal have created a lot of problems, as brokers in the US turned to global markets to dispose of the non-recycled E-Waste. But, most of the used electronics is

obsolete; as only 400,000 tonnes end up as E-Waste, the rest is stored with the consumers or donated or sold to repair and refurbishment shops. It may be that 360,000 tonnes of E-Waste are collected and processed by the informal recycling sector. Altogether the informal and formal collection efficiency may be at 75% for end-of-life equipment, what is not too bad but needs quality improvement (see: BCCC Nigeria/UNEP/EMPA, 2012). The informal sector is recovering around 52% of the materials contained in the collected E-Waste (approximately 280,000 tonnes), which are channelled to the formal recycling industry. The cooperation of the two sectors works for ferrous metals, aluminium and copper, but less for precious metals and plastics. Other materials are lost through burning and dumping. Locally adapted and labour-intensive recycling technologies should be used instead of expensive shredding and sorting machinery. And, pre-processed fractions of E-Waste can become part of recycling value chains working at regional and international levels.

Concerning waste batteries in Nigeria, a new problem emerges with the stand-alone solar installations which are becoming more and more important. This development is welcome, as it is part of the necessary transition to renewable energy, but more toxic lead acid batteries – which are a major component of standalone solar solutions – will end up at dumpsites across the nation after their use. This is hazardous waste, and so needs careful recognition for health and environment reasons.[107] The informal recycling of car batteries already leads to many deaths among children and adults, as there is no knowledge about the dangers of such activities. The activity of melting the car batteries to reclaim the scrap lead inside is conducted informally, out in the open air, and is done largely by women of the community, and the nearby children are particularly vulnerable to lead poisoning.[108] Similar treatment of batteries from solar installations may cause further harm through the practices of informal business activity. Because of the high lead-content of such batteries this is an economically very profitable activity but associated with

coming in the years 2015 and 2016 from Europe (77%), and not from the US (7%); see: https://www.ehn.org/how-much-e-waste-is-shipped-to-nigeria-2561214315.html. A considerable share of the used electronics shipped to Nigeria is not usable E-Waste and therefore is illegal to import it into Nigeria.

[107] See the Report by the Heinrich-Böll-Stiftung Nigeria (HBSN 2018): https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

[108] See: https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

extremely severe health risks. Improving the value chain to recycle old batteries is a complex business and can support environmental policies (by energy savings and less greenhouse emissions) as well as reduce health risks (but only, if the value chain of using old batteries for gaining lead scrap is properly understood and not interrupted). However, old batteries are too often manually broken to gain the lead scrap. Emissions of lead dust and of sulphuric acid affect the groundwater and the soils, but also damage the health of the humans working on old batteries. This situation is found also in parts of Nigeria like Lagos, Asaba, Onitsha, Kaduna, Ibadan or Ogun State where many metal recyclers and smelters are conducting their businesses in very dirty ways, ignoring completely the health and the environmental risks.[109] In Nigeria, over 110,000 tons of used lead-acid batteries are generated annually from automotive batteries and from alternative energy battery systems. These data were provided by research which was carried out by the Recycling and Economic Development Initiative of Nigeria (REDIN). The research reveals that there is urgent need for the Nigerian government to act through the Environment Ministry and the Environment Agencies, to speedily put in place instant policies to regulate the ULAB (Used Lead Acid Batteries) sector of Nigeria. A large-scale public awareness and training programme for the informal workers and businesses in the field is needed as part of the regulatory approach (see figure 10 on the handling of used batteries).

[109] See: https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

Figure 10: Informal and Unprotected Work on Used Batteries

Source: https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

There are however good news coming from Nigeria in this regard. Anambra State in Nigeria currently houses one of the cleanest lead recycling facility in West Africa, if not of the entire African continent.[110] According to International Lead Association (ILA) certified inspectors this recycling facility is a model for Nigeria. The facility has a closed loop system to ensure minimum environmental pollution, and an effective health mechanism for workers was put in place. The Nigerian government should encourage such formalized and standard recycling processes; this would not only create new and clean jobs for the unemployed youths but would also accelerate the production of "Made in Nigeria" batteries. As the recycling rate of lead is low in Nigeria with only 13%[111], a combination of formal and informal sector recycling activities of lead from batteries is needed. Some training is taking place to improve the situation, but it is marginal relative to the obvious needs all over Nigeria.[112]

[110] See: https://ng.boell.org/2018/05/23/africa%E2%80%99s-challenge-used-lead-acid-batteries-ulab-%E2%80%93-can-nigeria-take-lead

[111] See: http://www.offgridnigeria.com/nigeria-recycles-13-110000-lead-acid-batteries-annually-country/

[112] See: https://cloudenergy.com.ng/blog/managing-used-lead-acid-batteries

8.7 Managing the Problem of End of Life Vehicles in Germany

More than 40 million passenger cars and light duty vehicles are registered in Germany. However, this number is constantly changing as new and used vehicles are registered or old ones are deregistered or decommissioned. What happens to these vehicles over time? Not less than eight million passenger cars and light duty vehicles are decommissioned every year; but only three million motor vehicles are permanently deregistered annually. Not all these cars are End of Life Vehicles/ELVs (that is waste) but used vehicles (that is non-waste); a large share is exported regularly to other EU member states and is registered there. Another share of used vehicles is exported to non-EU countries. Only 500,000 of the three million motor vehicles that are permanently deregistered annually are ELVs, what means becoming waste.[113] ELVs need a careful attention from the side of environmentalists because of resource conservation and because of environment protection. Also because of health reasons the policy on ELVs is important. The environmentally sound disposal (meaning a proper and safe recovery and disposal which is compatible with public welfare) of ELVs is important because ELVs contain recyclable materials (for example steel and copper) which need to be reintroduced into the materials cycle for the purpose of protection of natural resources, but also materials that are harmful to the environment (for example heavy metals). ELVs are hazardous waste, based on thousands of components.[114]

The Directive 2000/53/EC on end-of-life vehicles and the German End-of-life Vehicle Ordinance[115] stipulated a recycling rate (reuse/recycling) of 80 per cent and an overall recovery rate (reuse/recovery) of 85 per cent of the average vehicle weight for the period 2006 to 2014. In 2015, these targets were raised to 85 per cent (recycling) and 95 per cent (recovery) respectively (BMU 2018/FME 2018, pages 32-34). These rates apply to the total volume of end-of-life vehicles (ELVs) in a given year; they do not have to be met for every ELV. The overall recovery rates of more than 100 per cent, achieved between 2010 and 2014, are due to the after-effects of

[113] See on the data about deregistering, decommissioning and waste (end-of-life vehicles): https://www.bmu.de/en/topics/water-waste-soil/waste-management/types-of-waste-waste-flows/end-of-life-vehicles/

[114] See: https://www.bmu.de/en/topics/water-waste-soil/waste-management/types-of-waste-waste-flows/end-of-life-vehicles/

[115] See on the German legislation: https://www.bmu.de/en/topics/water-waste-soil/waste-management/types-of-waste-waste-flows/end-of-life-vehicles/legislation-in-germany-end-of-life-vehicle-ordinance/

the 2009 environmental premium for the recovery of ELVs[116]: as the number of discarded ELVs in 2009 was approximately four times higher than the average annual amount, the capacities of dismantling and shredding facilities were exceeded, so that some ELVs had to be put into interim storage. In other words, fewer ELVs were treated or recovered than had been returned. The rates therefore dropped significantly in 2009, while still meeting the targets. Between 2010 and 2014, on the other hand, more ELVs were treated and recovered than had been returned each year, hence stockpiles from interim storage were successfully reduced. As a result, exceptionally high rates were achieved during these five years. In 2015, the situation returned to normal, and the after-effects of the environmental premium are no longer in evidence. Since 2005 (recycling) and 2006 (recovery) respectively, Germany has regularly exceeded the binding targets of 80 and 85 per cent for the period 2006 to 2014; and since 2006 (recycling) and 2010 (recovery) respectively, it has already exceeded even the higher targets of 85 per cent and 95 per cent, applicable only from 2015 onward (see also the BMU/UBA Annual Reports on the End-of-Life Verhicles[117], requested by the Economic Commission/EC). The recycling rates for various categories (metals, non-metals, etc.) look favourably, although the after-effects of the global recession and the stabilization programme (car purchasing premium) after 2008 are visible in the sequence of the recycling rates (BMU 2018/FME 2018, page 33). Also, the recovery rates clearly show the after-effects of the global recession of 2008/2009 (BMU 2018/FME 2018, page 34). The End-Of-Life Vehicles (ELVs) Policy of the European Union (EU) has an impact and this is important because every year 7 to 8 million tonnes of waste need to be managed.[118] Regularly the EU Directive is evaluated, and so the member states are requested to submit detailed reports with the requested data. Non-EU countries can learn from the mechanisms practiced in the EU and in the member countries.

Implications for Waste Management Reforms in Nigeria: It is interesting to ask why the problem of End-Of-Life Vehicles (ELVs) is not reported in the literature and the proposals

[116] In fact, this premium was an economic recovery programme and not an environmental programme.
[117] See, as an example: BMU/UBA, Jahresbericht über die Altfahrzeug-Verwertungsquoten in Deutschland im Jahr 2016 nach Art. 7 Abs. 2 der Altfahrzeug-Richtlinie 2000/53/EG; Access: https://www.bmu.de/fileadmin/Daten_BMU/.../jahresbericht_altfahrzeug_2016_bf.pdf
[118] See: http://ec.europa.eu/environment/waste/elv/index.htm

coming from Nigeria. Also, more recent reports and studies (as Oloko 2016) do not touch the issue. The main reason given is that there is an acute shortage of transport vehicles in countries like Nigeria, so that the import of used cars is regarded as a mechanism to escape the transport constraint (see Agbo 2011). Infrastructure is weak; this refers to roads, railways, waterways, air traffic, and urban transport. Used cars are imported in the belief that something of value can be used, either by mechanics or by recyclers or by business workshops or by other end consumers. The streets and construction sites in Nigeria are full of "junk vehicles" which had been abandoned by the owners, and many of them were imported as used cars some time back. They can be used for secondary materials or can be recycled to the same products or to other products. The informal sector is rich in its expertise to make transport vehicles out of abandoned cars. Studies show that complex technologies are needed to recycle in a coordinated way end-of-life-vehicles (ELVs). Examples are given from the development of such technologies and the establishment of large-scale facilities through Japanese carmakers (see Agbo 2011, pages 123-126). There is some uncoordinated re-cycling of iron and steel, aluminium, and plastic components of ELVs in Nigeria (Agbo 2011, pages 125-126). Iron and steel are used to produce concrete reinforcement rods and steel sheets for the building and construction industry. Aluminium is smelted to produce cooking utensils. Old vehicle batteries are used both internally and some are exported to countries like China where they are remanufactured, recycled, and at times the cell components are reused. The scrap scavengers in Nigeria go to different mechanic workshops collecting and buying disassembled and removed scrap components. There is a market for such components, as the scavengers supply these scraps to the smelting companies. Because of poor sorting of the scrap the quality of the recycled materials which are used for building materials is too often very poor, so that the rods and sheets for the building industry are of bad quality (making such products unreliable). Such products cannot be classified and standardized for getting certain quality marks. The poor sorting of the scrap before charging them into the furnace is a major problem in Nigeria. If the sorting of the scrap is of high quality, the quality of the output will as well be considered as acceptable. Although the recycling rate is not bad (around 36%), the quality of the materials recycled is often too low for quality products. A new development concept for countries like Nigeria is proposed. It is proposed to shift from the 3R concept (reduce, reuse, recycle) to the 6R concept (reduce, remanufacture, reuse, recover,

recycle, redesign). This change may result in savings and/or gains for both manufacturers and consumers. It is considered as essential to integrate the 6R criteria into all phases of the vehicle development process. An industrial strategy for Nigeria can benefit from the 6R concept if it is really becoming part of the implementation process. Such an industrial strategy needs to be coordinated with trade and regional integration policies. The reality is that unauthorized imports of cannibalized engines and of other vehicle parts are coming to Nigeria without effective monitoring. Such parts affect the ability to apply the 6R concept (see Agbo 2011). Although Lagos is establishing now a Vehicle Recovery Unit (VRU) to remove abandoned and accident cars from the highways and streets (see figure 11 on this crucial aspect of daily life in Lagos), the outcome of such an institutionalization may not be great if this measure is not embedded into a recycling strategy and the 6R concept.[119]

Figure 11: Abandoned Cars in Lagos, Nigeria

Source: https://www.sunnewsonline.com/lagos-to-commence-removal-of-abandoned-accident-vehicles/

The move towards such a Unit may have some security and decongestion advantages for traffic, it is also a costly purchasing programme for equipment and trucks to remove the abandoned and accident cars from the streets. Nothing is said in the proclamation about the final fate of the

[119] See: https://www.premiumtimesng.com/regional/ssouth-west/265125-lagos-creates-vehicle-recovery-unit-to-remove-abandoned-accident-vehicles-on-roads.html

removed vehicles, although the potential for recycling and remanufacturing is there. It is not at all clear how this measure is to be combined with the 6R concept (reduce, remanufacture, reuse, recover, recycle, redesign). The E-Waste Africa Project (EWAP) has brought new ideas and orientations to work towards sound end-of-life solutions in regard of waste management (see Öko-Institut et al. 2011). The informal sector has a great capacity for engineering and recycling solutions which could be improved, also to the benefit of using end-of-life-vehicles.

8.8 Management of Mineral Waste in Germany

Mineral wastes are the largest waste stream in Germany, with an annual volume of more than 275 million tonnes. They include construction and demolition wastes and excavated soils, as well as slags and ashes from incineration processes in energy and metal producing industries. The distribution shows that of major importance is soil and dredged material (with a share of 50.7%), followed by construction and demolition waste (32.0%), waste from thermal processes and waste from production processes (see BMU 2018/FME 2018, page 35). A significant fraction of mineral wastes is used by the construction industry, where they substitute primary construction materials with mineral wastes, for example as recycled grit in construction materials, or as a substitute for landfill construction materials or as backfill material in open pit mining[120]. Currently, there is no federal regulation on the production and use of mineral wastes as substitute construction material in Germany. Discussion is ongoing of moving from an open-loop system to a closed-loop system; construction and demolition waste from structural engineering is used now in civil engineering for earthwork and the road construction sector. In the future such waste could be used in a closed-loop system for concrete production in the structural engineering sector (see Weil/Jeske/Schebek 2006). So, these wastes can be kept in a closed cycle, and the disposal in a landfill can be avoided. But there are some definite limits to such a type of disposal of mineral wastes. An assumption of a closed-loop solution is that the usable concrete and brick fractions can be extracted from the construction and demolition waste, and that these fractions can be separated from each other. Processing plants work for non-mineral wastes and are not prepared for such separation work. Separation at the construction site through selective demolition is expensive and has limitation but is a precondition for the work of processing

[120] Open-pit mining is still important in Germany in the case of brown coal.

plants. The purity of the waste sorts is relevant. Saving of mineral resources through the closed-loop system has to be balanced by the saving of energy resources and climate protection in the open-loop system (see Weil/Jeske/Schebek 2006). There are arguments for a stricter control of mineral wastes, but solutions are not easy. The Federal Government in Germany is planning to introduce the Substitute Construction Materials Ordinance, designed to promote the use of secondary raw materials, thereby strengthening the circular economy and preserving valuable primary raw materials. The secondary raw materials used for construction are however strictly controlled in order to protect valuable soil and groundwater resources, and to prevent the unintentional release of environmentally hazardous substances. However, for many years the discussions are going on without any result because the opinions between government and industry are too different.[121]

Implications for Waste Management Reforms in Nigeria: There is not really reference to a sustainable management of construction and demolition waste (C&D waste) in Nigeria, but there is some discussion going on how to move towards a more sustainable use of construction and demolition waste, to the benefit of the environment and the groundwater and to the advantage of construction businesses and the owners of the buildings (see Omotayo/Akingbonmire/Ikumapayi 2017). The many conflicts between environmental and economic goals are obvious. There are however possibilities to control the construction and demolition waste through the regulation of the construction industry (see for Nigeria the study by Wahab/Lawal 2011). In all tendering processes for the construction of buildings "waste management plans" could have beneficial effects, leading the designers and the construction companies to think about all phases of waste management (from the design to the construction, on-site storage and demolition phase). Of importance are also last-minute changes of building plans, the prices of construction materials, the construction costs, the lack of regulations concerning the materials used for construction and the mandatory presentation of waste management plans (see Omotayo/Akingbonmire/Ikumapayi 2017). All these are important ideas, but do not seem to have practical relevance for the construction industry in Nigeria. It is also mentioned that the markets for C&D waste could be used for sourcing cheap and adequate materials for new buildings, but only if such markets are

[121] See on the story the report from 5/2014: https://www.at-minerals.com/en/artikel/at_Problems_with_mineral_wastes_2011562.html

better organised and are located near to the construction activity. Waste management plans could help to commercialise these resources much better (see Mudashiru et al. 2016). Design professionals, construction firms and contractors can stimulate the markets for waste materials by specifying for buildings certain used materials and new products from recycled materials.

8.9 Waste Exportation and Importation Practices and Policies of Germany

The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, which entered into force in 1992 in Germany, seeks to ensure environmentally sound waste management practices worldwide and to control trans-boundary shipments of hazardous wastes (BMU 2018/FME 2018, pages 36-38). More than 180 countries and the European Union (EU) are now Parties to the Convention; the Waste Shipment Regulation (WSR) of the EU and the Waste Shipment Act (WSA) of Germany are complex regulations to avoid damage to the global environment[122]. Parallel to the Basel Convention the OECD countries have developed the OECD Council Decision which did establish a system for the notification, identification and control of wastes which were destined for recovery.[123] Germany's Waste Shipment Act/WSA (AbfVerbrG/Abfallverbringungsgesetz) contains the legal provisions which are necessary for the implementation of the Basel Convention in Germany.[124] There is a Focal Point in the UBA to administer the Basel Convention issues.[125] Consent is required especially for hazardous waste. The EU waste shipment statistics based on the list of waste codes is important to record the flows through, to and from Europe for all types of waste.[126] In cases where waste shipments are subject to consent, the authorities check whether there are any objections to the shipment. The data on imports and exports show that there is in quantitative terms a smaller role of "consent shipments" relative to "non consent shipments", but there is an import surplus for waste with "consent required" while there is an export surplus for "waste not requiring consent" (BMU 2018/FME 2018, page 37, Figure 18). The shipment is tracked through a "movement

[122] The EU has transposed the Basel Convention into binding law for all Member States with the Waste Shipment Regulation. The Waste Shipment Act contains supplementary provisions applicable to Germany.
[123] See the statement from the Umweltbundesamt (UBA): https://www.umweltbundesamt.de/en/topics/waste-resources/transfrontier-shipment-of-wastes
[124] See on the Law in Germany: http://www.gesetze-im-internet.de/abfverbrg_2007/
[125] See: https://www.umweltbundesamt.de/en/topics/waste-resources/transfrontier-shipment-of-wastes
[126] See the full article on the types of waste imported and exported: https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_shipment_statistics_based_on_the_European_list_of_waste_codes

document". The high level of waste imports into Germany compared with waste exports is primarily attributable to the high standards of recovery and the disposal structures in Germany, coupled with economic factors. A new tool is used basis on the EU regulation to help officials at customs to identify illegal shipments of waste.[127] The waste imports of Germany are part of a business to earn money through new waste separation technologies.

Implications for Waste Management Reforms in Nigeria: Imports and exports of waste to and from Nigeria play a role. Recently the solid waste imports ban by China has been discussed in Nigeria as a welcome business opportunity.[128] The ban on imports of many types of solid waste, also recycled plastics, may be regarded as a push for the Nigerian recycling industry. Chances are there to build bottle-to-bottle recycling plants or plastic recycling plant in Nigeria. From 30 million metric tons of waste in Nigeria 2.5 million metric tons are plastic waste which could be processed directly. The technological capabilities are there and can be used fully. China could also bring such technologies and businesses through direct investment to Nigeria. It is however necessary to control much more the illegally shipped E-Waste (TVs, monitors, photocopiers, fridges, etc.) which are coming mainly from European countries mainly inside of used vehicles or as part of other shipments to Nigeria. The volume is huge (60,000 tonnes in the years 2015 and 2016), and a quarter of the used equipment is not working anymore.[129] Imports of Used Electrical and Electronic Equipment (UEEE) are too often not complying with international agreements, such as the Basel Convention. There is a role for the Sustainable Cycles (SCYCLE) programme of the United Nations University (UNU) to cooperate with Nigeria and other African countries on solving the E-Waste problem, especially in creating awareness for policymakers and legislators, but also for researchers and industrialists.[130] As there is some scope for intensified informal sector businesses, more advice is also needed to restructure the Nigerian recycling industry. The informal sector is rich in knowledge, capabilities and expertise.[131] But, most

[127] See: http://ec.europa.eu/environment/waste/shipments/index.htm
[128] See: http://chinaplus.cri.cn/news/china/9/20180108/74953.html
[129] See: https://ehs.unu.edu/media/press-releases/thousands-of-tonnes-of-e-waste-is-shipped-illegally-to-nigeria-inside-used-vehicles.html
[130] See on the SCYCLE programme of the United Nations University: https://ehs.unu.edu/vice-rectorate/sustainable-cycles-scycle#overview
[131] See the survey of opportunities and challenges for the Nigerian informal sector to contribute to the E-Waste recovery and recycling industry: Öko-Institut/Basel Convention Centre Nigeria 2011 (Access:

important is it to bring together in Nigeria import policies, export policies, industrial policies and waste management policies; how to do this is not yet clear. But also, EU and Germany needed decades to get to such a package of policies. It may be a way to develop international recycling value chains, based in Lagos and other port towns, together with China, India and the European Union.

8.10 Avoiding dangerous environmental and health impacts through waste management in Germany

Generally, a key aim of waste management policy in Germany is to prevent adverse environmental impacts. Waste management can make a big contribution to climate protection.[132] Recycling, the energetic use of residual waste, and the use of landfill gas contribute to climate protection. Germany maintains very high standards to protect water, soil and the air from the emissions associated with waste treatment and storage. Not least, the ban on dumping untreated waste, in force since 2005[133], has helped to continuously reduce emissions of climate-damaging gases (primarily methane) from landfills. The capture and use of landfill gas will contribute to the reduction of GHG emissions, and this is done by mechanical and thermal methods. Recycling and the harvesting of energy from waste also help to minimise greenhouse gases (GHG).[134] In this way, since 1990, annual emissions from the waste management sector have been reduced by some 56 million tonnes of carbon dioxide equivalents[135]. Further reductions by 65 million tonnes are expected by 2020. This waste management policy as practised in Germany is a vital part of climate change mitigation policy (see BMU 2018/FME 2018, page 39). All this has contributed

https://www.oeko.de/en/publications/p-details/informal-e-waste-management-in-lagos-nigeria-socio-economic-impacts-and-feasibility-of-internatio/)

[132] See: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/climate-protection-in-the-waste-management-sector

[133] Strict criteria for waste disposal which are contained in the Abfallablagerungsverordnung" (ordinance on waste disposal) have to be met; this ordinance was enacted in 2001 and has been incorporated into the "Deponieverordnung" (landfill ordinance); see: https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/climate-protection-in-the-waste-management-sector.

[134] Although the waste management policy of Germany is related to the policy of reducing greenhouse gas emissions, the targets for the overall reduction of greenhouse gas emissions in Germany are ambitious but not always followed according to the formulated goals; see: https://www.umweltbundesamt.de/en/indicator-greenhouse-gas-emissions#textpart-1

[135] Carbon dioxide equivalent is a way of measuring the global warming potential of a greenhouse gas compared with that of carbon dioxide. This reduction in emissions accounts for more than 20 per cent of the international "Kyoto targets" that Germany has pledged to meet.

to climate protection, but the overall effect is studied carefully by the Umweltbundesamt (UBA). For the EU, the potential can be exploited more and more. According to the available statistics from the EU, the savings of GHG emissions are of major importance.[136] Data collection, also for candidate countries, is done by European agencies, such as the European Environment Agency (EEA).[137]

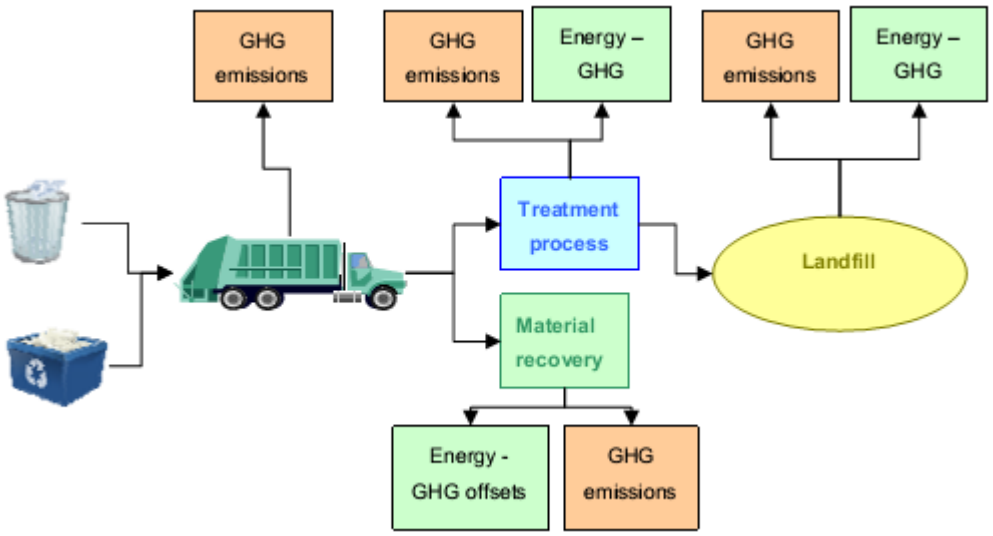
Implications for Waste Management Reforms in Nigeria: For Nigeria, such changes in waste management and climate protection policies are yet to come as open dumping of waste in landfills are still used extensively. More recent reports (such as Diawuo 2013) come to interesting conclusions in this regard. Although the waste management sector as such is in global terms only of minor importance as a contributor to the GHG emissions, better waste management practices can impact quite positively on many sectors to reduce GHG emissions, such as energy, forestry, mining, transport, agriculture, tourism, transport, trade and manufacturing. Life Cycle Analysis (LCA)-based studies show that the impact of progressive waste management options on GHG emissions and on climate protection can be great. The expected large increases of methane-producing conditions in landfills in Nigeria due to waste generation in cities and rural areas can be compensated by better practices in formal and informal waste management sectors, by involving the middle class people through their consumption and transport behaviour, by involving the large and small industrial companies, and by involving also the urban poor to recycle the waste for their own income generation and for overall environmental protection. The GHG emissions in the waste management value chain have various sources, as can be seen in the figure 12 below. Most important in the waste management value chain is the role of the landfills, the transportation system, the pre-treatment and treatment of waste, and the way of working through policies on the hierarchy of waste management objectives. Prevention of waste generation is better than reusing products, as can be seen from the impact of using outdated old

[136] See a full article on the issues: https://ec.europa.eu/eurostat/statistics-explained/index.php/Archive:Greenhouse_gas_emissions_from_waste_disposal

[137] The data for the waste-related GHG emissions are obtained from the European Environment Agency (EEA), and the EEA reports are prepared for the United Nations Framework Convention on Climate Change (UNFCCC). It should be noted that waste nomenclatures may differ: incineration in this context covers only incineration without energy recovery.

vehicles for transport, leading to high carbon dioxide emissions. Also, the length of ways for transporting waste is relevant.

Figure 12: Simplified schematic presentation of the waste management system and the related GHG emissions (in urban MSWM)



Source: Diawuo 2013, page 25

The data (in Diawuo 2013) show the dimension of GHG emissions for Nigeria, South Africa and Ghana, by separating for the various steps of waste management and for either single sectors and/or for all sectors of the economy. A country like Nigeria with a high rate of rural and urban poor can through recycling - at the household level and at the level of the formal and informal waste management systems - reduce the waste which is responsible for the high GHG emissions. Poverty reduction can also be supported by income generation through recycling activities; this will also help to prevent climate change and to protect the environment. Better working conditions in the informal and in the formal waste management sectors are an option to improve the recycling rate, but broader conceived poverty reduction policies will also facilitate waste prevention, reuse of products, and recycling. Looking at the whole waste management value chain (see, as an example, Sridhar/Hammed 2017) we see that the emissions of methane and of carbon dioxide GHG can be reduced, by policies to focus on the traditional practice of dumping

waste at open landfills, on avoiding transportation long ways with worn-out old vehicles, and on indiscriminate burning. A whole value chain approach would be requested, including not only the focus on GHG methane-based emissions from organic waste, but also the GHG carbon dioxide emissions through transportation, reuse of certain energy-intensive products, and certain recycling activities. While some authors (like Sridhar/Hammed 2017) focus in their policy advice on the informal sector and on the poor to work on their awareness and action, others (like Nabegu 2012) think that formalization of the waste management system may solve the problems of dumping waste on open landfills and of transporting waste through outdated vehicles.

9.0 Waste Generation and Waste Management in the Country State and the Municipality of Bremen, Germany – Pragmatic and Innovative Approaches

Germany has a selective system of waste disposal. Since the local authorities are charged with the task of waste management, this commitment can vary from town to town. In Bonn, for example, waste disposal is organized in the following way: Every household in general has 4 bins (see figures 13-16): a black, a green, a blue and a yellow one.[138] The black bin is for residual waste, the green bin is for organic waste, the blue bin is for waste paper, and the yellow bin is for light weight packaging (plastic). In the case of Bremen, every household in general has 4 bins: a black, a blue, a brown, and a yellow one. The black bin is for residual waste, the brown is for organic waste, the blue bin is for waste paper, and the yellow bin is for light weight packaging (plastic).[139] All the bins are well labelled (for identification and further administrative processing) and can easily be identified by the users. In Bremen city, the waste needs to be sorted according to the material content to be disposed of, and as it was agreed according to the latest contractual terms between the municipality and the respective waste collectors. The content of each of the bins in Bremen municipality is discussed below (see the figures 13-16 below):

[138] See on the concept of Bonn: https://www.bonnorange.de/

[139] See on the case of Bremen municipality: https://www.die-bremer-stadtreinigung.de/privatkunden/gebuehren/tonnenbestellung-2283

Figure 13: The Residual Rubbish Bin

Source: DBS/Die Bremer Stadtreinigung;

Note on the Content of the bins in Bremen: See the description of the content of the bins in Bremen:

https://www.die-bremer-stadtreinigung.de/sixcms/.../BEB065_Abfall_A4_dt_WEB.pd...

Residual Rubbish Bin: Used wallpaper, pet litter, small pieces of wood, light bulbs, household articles, dishes, cups, crockery, swarf and wood shavings, spoilt paper and cardboard packaging, spoilt wrapping and packaging material, buckets, dispersion paint, medicine, ointment, tablets, nappies, vacuum cleaner bags, ashes, document files, and audio and video cassettes are to put into the residual rubbish bin. Generally, the residual waste bin is for non-recyclable wastes. Recyclable waste, waste requiring special disposal methods, bio-waste, and small electrical appliances must not be put into the residual waste bin.

Figure 14: The Organic Waste Bin

Source: DBS/Die Bremer Stadtreinigung

Organic Waste Bin: The following items are to be put into the organic waste bins: kitchen waste, such as bread and cake leftovers, eggshells, fruit and vegetable waste, coffee grounds, coffee filters and tea bags, fish, meat, and solid food waste. Plant waste, such as withered flowers, balcony plants, the content of flowerpots, plant cuttings, and cut grass in small amounts should also be put into the organic waste bins. However, pollutants, electric and electronic appliances, and recyclable material are not allowed in organic waste bins.

Figure 15: The Waste-Paper Bin

Source: DBS/Die Bremer Stadtreinigung

Waste-Paper Bin: Newspapers, magazines, brochures, paper, and cardboard packaging are to be put into the waste-paper bin. Used wallpaper, spoilt paper and cardboard packaging, and coated paper – all these materials are to be put into the residual waste bin; hence they must not be put into the waste-paper bin.

Figure 16: Yellow Bag/Bin/Container

Source: DBS/Die Bremer Stadtreinigung

Yellow Bag/Bin/Container: The following items are to be put into the yellow bag or bin or container:

Sales packaging made of plastic: e. g. shopping bags, cling film, plastic and aluminium wrapping, plastic bottles used for shampoo and washing liquid, yoghurt or margarine containers, fruit and vegetable trays.

Packaging made of metal: cans, tins, aluminium trays, caps, lids.

Composite materials: drink and milk cartons, vacuum packaging.

Paper and cardboard, glass, nappies, audio and video cassettes, plastic products such as buckets, watering cans, basins, cover sheeting and pollutants are not allowed to be put into yellow bags/bins.

For these four bins, the collectors (selected by public tender) have quite different contracts and modalities. The further use of the waste decides about the contracting modalities.[140] Because of the volume of contracts, an EU-wide public tender is required. The criteria set for the public tender call are important.

Bulk Rubbish is another major activity for waste management. Because of the mixture of waste, strict regulations need to be enforced and a clever system for removing the items is requested (see figure 17 with a variety of items). There is a lot of planning needed to work successfully on this delicate issue of waste management (and there is a need for secrecy so that the public benefits from further using the items, and not only some private agents).

Figure 17: Bulk Rubbish (Sperrmüll)

Source: DBS/Die Bremer Stadtreinigung

Bulk Rubbish: In this category are sofas, couches, cupboards, tables, chests of drawers, trunks, armchairs, chairs, stools, mattresses, slatted beds, shelves/shelf units and component parts (up to

[140] See on the workings and operations of the responsible agency, the corporation Die Bremer Stadtreinigung: https://www.die-bremer-stadtreinigung.de/

2 m long and tied together), suitcases (empty), carpets, ovens, bedsteads, buggies and bicycles[141]. The following items are not allowed as bulk rubbish: Waste which is too heavy to be safely loaded by two people by hand; surplus building materials (e. g. windows, doors, wooden floors, floorboards, sinks, baths); recyclable material, such as glass, paper and cardboards, textiles, yellow bags, garden waste and tree-cuttings; loaded sacks and cardboard boxes, harmful substances, waste containing asbestos, oil tanks made of plastic, car wracks and car parts, motor cycles, and tires.

9.1 Waste Management in Bremen, Germany and the Role of Innovation Policies

Still open is the right balance between public and private actors in waste management. It is obvious that private actors play a role in innovation, but also public entities have an increasing role in this. Innovations are important to impact on the percentage of re-used items, re-cycled items, composted items, and burned items. Nehlsen is a waste management company in Bremen, which is cooperating with the public waste management company, and being active towards generating innovations in various directions. Innovations should be promoted along the whole waste management value chain (collection, sorting, treatment, disposal and incineration of solid and liquid wastes); also, innovations in the field of secondary raw materials and refuse-derived fuels are aimed at as well as innovations in the field of sewer maintenance & services). Nehlsen is also planning, building and operating waste treatment plants.[142] Innovations pay off. Data for Bremen are of interest. Concerning residual waste, there is a nearly 100% energetic use; concerning paper and pasteboard, there is also a nearly 100% re-using rate; concerning garden waste, there is a nearly 100% composting rate. Concerning bulk waste, there is a 95% energetic use, while 5% are re-used; concerning bio-waste, there is a nearly 100% re-use; concerning metals, there is also a nearly 100% re-use rate; concerning pollutants, contaminants and

[141] There are some organisations in Bremen which accept other household items in good conditions, to be found at: www.gebraucht-und-gut.de. One can put a call across to them if one has items which are in good condition and if it is intended to dispose them off. This will lead to more re-use of products and to a socially balanced use of the materials in the future.

[142] See on the company philosophy:
https://en.nehlsen.com/.../EN/.../Nehlsen_Waste_Management.pdf

hazardous waste, there is a 50% re-use rate, while 50% are disposed of. [143] Innovations are an important element for reaching the objectives of the "circular economy". The country state and the municipality of Bremen have various advantages to go ahead with economic and technical innovations in waste management – the state is geographically small; the public institutions and the private companies are in close contact; the logistics infrastructure is at high levels and improving; the scientific infrastructure is excellent; urbanization and digitalization are mutually supportive; and the human resources development facilitates the supply of skills.

As a country state in Germany, Bremen is requested to develop waste management plans (Abfallwirtschaftspläne). This is part of the obligation resulting from the Waste Management Circular Economy Act (Kreislaufwirtschaftsgesetz) of Germany. And, the public waste management authorities need to develop waste management concepts and balance sheets. The waste management plans are requested to describe the objectives of waste prevention, use of waste and waste disposal as well as the situation with regard of waste volumes and types of waste in the country state.[144] Also, the available installations and the equipment for waste disposal are to be recorded in detail. Exports and imports of waste from and to the region as well need to be documented. For a ten-year period, the projections about future developments in regard of waste volumes and structures are to be presented. These requirements follow from the European Waste Management Ordinance (Europäische Abfallrahmenrichtlinie). Packaging waste and hazardous waste are to be considered in separate chapters according to the European Waste Management Ordinance. Bremen has now written its third Waste Management Plan. The Country State of Bremen is responsible actor to administer the Waste Management Act for Bremen (Bremisches Landesabfallgesetz) to the effect that the public waste management authorities can fulfil their duties and tasks, especially to develop concepts about the use and

[143] See on the policy of the government of Bremen in this direction: https://www.bauumwelt.bremen.de/umwelt/abfall-23790; and Nehlsen plays a role in such high rates of recovery/recycling/reuse and energetic use.

[144] See the booklet on the Waste Management Plan for the planning period of 2017-2016: https://www.bauumwelt.bremen.de/umwelt/abfall/abfallwirtschaftsplan_und_abfallbilanz_fuer_das_land_bremen_2017-59662

disposal of waste Abfallwirtschaftskonzepte).[145] All the five years new concepts have to be presented by the public waste management companies. The country state has a public agency for the municipality of Bremen - Die Bremer Stadtreinigung, formerly the Entsorgung kommunal (Eko)-Umweltbetrieb Bremen[146] - and one for the municipality of Bremerhaven – Entsorgungsbetriebe Bremerhaven (EBB)[147]. The public waste management agencies also are requested to present waste management balance sheets (Abfallbilanzen). The waste balance sheet for Bremen municipality presents information on the structure of the area/region, the volumes, uses and forms of disposal of waste, and times series on waste to see the changes over time. Five categories of waste are recorded in the waste balance sheets: waste from households, construction waste from private households, industrial waste, infrastructure waste, and specific packaging waste (packaging materials from sales of products according to the Packaging Waste Act/Verpackungsverordnung) and waste batteries. There are eight categories how waste is disposed of: municipal waste (Siedlungsabfälle), construction waste (Bauabfälle), waste from gardens and parcs (Garten- und Parkabfälle), Bio-Waste, Textiles and Shoes, Metals, Hazardous Waste, and Electric and Electronic Equipment/Parts[148]. It is important to collect this information at the level of country states in Germany to come then to an overall balance sheet for Germany and then also for the EU. The Balance Sheet for Germany (see Statistisches Bundesamt/Federal Statistical Office, Abfallbilanz 2016, erschienen 2018) also contains important methodological explanations. For example, the total volume of waste is composed of Municipal Waste plus Waste from extraction and treatment of Raw Materials plus Construction and Demolition Waste plus Other Waste, such as Industrial Waste, what is then summed up as Net Volume of Waste (Nettoaufkommen) plus Waste from treating waste in Waste Treatment Plants, summed up as Gross Volume of Waste (Abfallaufkommen insgesamt). Removing waste, through disposal and thermic treatment or other forms of treatment of waste, and using/reusing waste, through energetic uses and forms of reusing separated materials, are also accounted for in the waste

[145] The most recent Waste Management Concept 2014 by EKO/Die Bremer Stadtreinigung for the municipality of Bremen is a five-year strategy paper. The next one is due in 2019. See on the concept 2014: https://www.die-bremer-stadtreinigung.de/.../BEB077_RZ_AWK_2014_Web.15187.p..

[146] See on the public waste management company for Bremen town: https://www.die-bremer-stadtreinigung.de/

[147] See on the public waste management company of Bremerhaven: https://www.bremerhaven.de/de/verwaltung-politik/buergerservice/entsorgungsbetriebe-bremerhaven/entsorgungsbetriebe-bremerhaven-ebb.16447.html

[148] See on the current Waste Balance Sheet/Abfallbilanz 2016: https://www.die-bremer-stadtreinigung.de/.../BEB154_Abfallbilanz_2016_WEB.pdf

balance sheets for Germany. The Net Volume of Waste is given as 325 to 350 million tonnes per year for Germany, but the share of construction and demolition waste is credited with around 60 per cent of the overall volume. Only 14 % is municipal waste, and hazardous waste has a share of 5%.[149] The country state of Bremen has a different distribution of forms of wastes, because Bremen is composed of two towns (municipalities), while there is no hinterland as in the most country states of Germany (see on Bremen the recent Abfallbilanz 2016 and for Germany: Statistisches Bundesamt 2018, Abfallbilanz 2016, and Statistisches Bundesamt, Statistisches Jahrbuch 2018, Chapter 18 on Umwelt/Environment). This framework in EU, Germany and Bremen for stakeholders, institutions, strategies and policies ensures a high level of innovations along the waste management value chain. Germany is rich in developing environment technologies for domestic use and for export, also to developing countries. Nehlsen waste management company in Bremen - with worldwide 2,000 employees - is active in Africa.[150] A high rate of innovations as in the case of Nehlsen adds to the value of the waste management value chain.

However, beside of the technical innovations, economic innovations are still important. How is the waste management value chain organized in Bremen and in other states of Germany? This is the question in this paper, as the purpose is it to learn for a rearrangement of such value chains in Nigeria. Innovations are possible at all levels of the value chain. For example, the incinerator facility of Bremen had been modernized by the private electricity, water, sewerage, and gas company swb.[151] The company is also active in areas such as Internet, Mobile Phone, Services, Energy-Saving Facilities, District Heating, and E-Mobility. Most of the innovations came through by laws and regulations in Germany, by setting limits, by prescribing waste separation, etc. Innovations are also coming from the mix of activities – from electricity, gas, water, waste management, mobile phone and Internet. But the innovations are also supported strongly by the experience gained through the services provided for the customers. The affiliate company swb

[149] See on these data sources from the Federal Environment Office/Umweltbundesamt/UBA: https://www.umweltbundesamt.de/themen/abfall-ressourcen/abfallwirtschaft

[150] See: https://ghana-nrw.info/nehlsen-city-waste-ltd/?doing_wp_cron=1553088510.2013700008392333984375

[151] See on the portfolio of activities of swb AG: https://www.swb.de/?gclid=EAIaIQobChMI4qeXjq6R4QIVBp7VCh0crgVrEAAYASAAEgLFfvD_BwE

Entsorgung is active in major areas of using waste for energy production, either based completely on burning waste or using waste beside of burning coal. The revolution in services through Industry 4.0 developments may lead to a new round of innovations in waste management. In the context of Industry 4.0 there are more discussions about innovations linking "intelligent containers" and "intelligent bins" for waste to traffic, disposal facilities, accounting, planning and payment centres. Innovations should focus not only on municipal waste, but also on construction and demolition waste and on hazardous waste. Innovations on waste management need to include public and private sectors.

More innovations are however needed to prevent waste generation and to give incentives for the re-use of items. Also, more information and education of consumers/households/and of producers in industry should become part of an innovation strategy from the side of the Municipal Waste Management Agencies of the country state of Bremen. The poor record of Bremen and all of Germany with regard of the criterion "existence of an own Waste Prevention Programme (WPP)" and of the criterion "existence of a coherent and future-oriented Waste Management Plan (WMP)" means that innovations in this regard, becoming relevant at the political and societal level, are overdue. Also, the market structure is of relevance. In Bremen, one major private collector company is dominating the market, and some few other collectors have a niche (with orders from industry and offices). Other private companies play some role in recycling, re-using and separating waste. Although the EU-wide public tender system has the potential to bring changes, the process of reform may be complicated. And, it is an open question if the tender system, which is entrusting private collectors with a performance-related contract, could be improved by industry 4.0 strategies. It may be that industry 4.0 strategies will lead to a reduction of volumes of waste, but it can be that dominant industrial and services firms will govern also the waste management system. It is, however, a valid argument that new technologies developed in the context of industry 4.0 can help to realize the circular economy (Lutz, D./M. Nascimento/V. Alencastro et al., 2018).[152]

[152] See on the relationship between industry 4.0 technologies and enabling circular economy practices the article by Lutz/Nascimento/Alencastro et al. 2018: https://www.researchgate.net/publication/329220560_Exploring_Industry_40_technologies_to_enable_circular_economy_practices_in_a_manufacturing_context_A_business_model_proposal; an increasing number of articles

Bremen is one of the 16 Country States of Germany[153]. Germany is a Federal Republic consisting of sixteen Country States, and the sixteen country states are represented in the upper chamber of the parliament, the Bundesrat (Federal Chamber). Responsibility for waste management and environmental protection is shared between the Federal Government, the Country States, and the local/municipal authorities. The Federal Ministry of Environment sets priorities, participates in the enactment of laws, oversees strategic planning, information and public relations, and defines the requirements for the various forms of waste treatment/disposal facilities.[154] In the context of the German RETech Partnership the Ministry is trying to reorganize the waste management and recycling industry partners and value chains of Germany.[155] This is a partnership for all segments of the German recycling and waste management industry – with the purpose to strengthen their competitiveness on domestic and international markets. With a global market share of 25 % the German recycling and waste management industry is well prepared to contribute to environmental protection and climate action. Thereby, the standards of waste management and recycling can be raised at global levels. The partnership is described as stated below: "RETech consolidates companies and institutions from the entire area of the waste management and recycling industry from collection and logistics to treatment and marketing as well as consultation, planning, research and teaching under one roof. The RETech activities are supported by an advisory body in which the BMU[156], the BMBF[157], the BMWi[158] and BMZ[159], UBA[160], GIZ[161], KfW[162] as well as the BDE

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and books is now considering the relationship between industry 4.0 and waste management chains, but also the relationship of industry 4.0 to circular economy practices.

[153] Although the country state of Bremen is a quite small one judged by area and population, one may find in this area innovative waste management policies and practices, and so it is interesting to present the case in this paper.

[154] See on the many tasks of the Ministry (BMU/FEM): https://www.bmu.de/en/topics/water-waste-soil/waste-management/

[155] See on the focus of this partnership and the major objectives: https://www.retech-germany.net/retech/?L=1

[156] See on the respective Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit/BMU: https://www.bmu.de/

[157] See on the Bundesministerium für Bildung und Forschung/BMBF: https://www.bmbf.de/

[158] See on the Bundesministerium für Wirtschaft und Energie/BMWi: https://www.bmwi.de/Navigation/DE/Home/home.html

[159] See on the Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung/BMZ: http://www.bmz.de/de/index.html

[160] See on the Umweltbundesamt/UBA. https://www.umweltbundesamt.de/

(Bundesverband der Deutschen Entsorgungs-, Wasser- und Rohstoffwirtschaft e. V.)[163] associations, the bvse (Bundesverband Sekundärrohstoffe und Entsorgung e. V.)[164], VKU (Verband kommunaler Unternehmen e.V.)[165], VAK (Verband der Arbeitsgeräte- und Kommunalfahrzeugindustrie e.V.)[166] and VDMA (Verband Deutscher Maschinen- und Anlagenbau e. V.)[167] cooperate. Due to this network the RETech platform provides a unique opportunity for supporting the establishment of a well-ordered waste management industry, improving the requirements significantly for the export of German waste management and recycling technology." All these associations, government offices, companies and financing institutions increase the innovative power of the waste management and recycling industry of Germany. The rate of innovations is dependent on the quality and the intensity of cooperation. It is obvious that the speed of innovative activity is nowadays dependent on a stakeholder cooperation approach, because legislative and regulatory measures, industry and trade policy measures, R&D initiatives and firm-based decisions, strategies and operations are interdependent and mutually supportive.

Each Country State adopts its own waste management act (WMA), containing supplementary regulations to the Federal law, e.g. concerning regional waste management concepts and rules on requirements for disposal. There is no federal waste management planning body at the level of the Federation in Germany. Instead, each Country State develops itself a waste management plan (WMP) for its area (EEA[168], 2009). However, most important for the operational level is the municipal policy (with laws such as the Local Waste Management Law (Abfallortsgesetz).[169]

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[161] See on the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH/GIZ: https://www.giz.de/de/html/index.html

[162] See on the Kreditanstalt für Wiederaufbau/KfW: https://www.kfw.de/kfw.de.html?wt_cc1=brand&wt_cc2=home&wt_mc=2589700302_160560286783&wt_kw=e_2589700302_kfw&wt_cc3=2589700302_kwd-116666459_160560286783

[163] See: https://bdi.eu/der-bdi/mitglieder/bde-bundesverband-der-deutschen-entsorgungs-wasser-und-rohstoffwirtschaft-ev/

[164] See: https://www.bvse.de/

[165] See: https://www.vku.de/

[166] See: https://www.vak-ev.de/

[167] See: https://www.vdma.org/

[168] See on the European Environment Agency/Europäische Umweltagentur (EEA): https://www.eea.europa.eu/de; and about their role on waste management issues: https://www.eea.europa.eu/de/themes/waste

[169] See on the so-called „Ortsgesetz über die Entsorgung von Abfällen in der Stadtgemeinde Bremen" (Abfallortsgesetz):

There is such a law for the township of Bremen, and as well one for the township of Bremerhaven. From the EU level down to the municipal/local level a high intensity of regulations gives the frame for innovations and operations on waste management and recycling.

The capital of the Country State of Bremen is Bremen, and the country state has a population of 671,488 people (557,464 in Bremen and 114,024 in Bremerhaven) who are located on a land area of 419.4 km^2, which translates into a population density of 1,601.07 inhabitants per km^2.[170] Bremen is the second most populous city after Hamburg in Northern Germany and the eleventh most populous one in Germany.[171] The GDP of the country state of Bremen in 2017 was €33.662 billion[172]. Although Bremen is considered as a city state, it consists of two parts, the enclaves of Bremen town and Bremerhaven town in Niedersachsen (Lower Saxony). Both cities are surrounded by the state of Lower Saxony, and both towns of the country state of Bremen are located on the river Weser. Therefore, a close cooperation with the government of Lower Saxony and with neighbouring areas and towns is important for the economic development of Bremen. The concept of the Metropolregion Nordwest is an instrument for such a neighbourhood policy.[173] In the association named "Metropolregion Bremen-Oldenburg im Nordwesten e. V.", it is so that many actors from politics, administration, economy and business, science and culture cooperate to develop the region towards sustainable growth. The region encompasses various major towns like Bremen, Oldenburg, Bremerhaven, Wilhelmshaven and Osnabrück. Bremerhaven is an important container port and this town is home of various industries (food, shipbuilding, machinery, wind power, etc.), and of important maritime R&D and cultural institutions[174]. GDP (Gross Domestic Product)/GRP (Gross Regional Product) per capita in the country state of Bremen was in 2017 €50,130 Euros.[175] The map of Germany (figure 18) showing Bremen and the other German country states is presented below.

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https://www.transparenz.bremen.de/sixcms/detail.php?gsid=bremen2014_tp.c.64076.de&template=20_gp_ifg_meta_detail_d

[170] See general information on the country state of Bremen: https://landesportal.bremen.de/

[171] See the list of the 15 most populous towns in Germany: https://www.voucherwonderland.com/reisemagazin/groessten-staedte-in-deutschland/

[172] See on the GDP data for the country state: http://en.wikipedia.org/wiki/List_of_German_states_by_GDP

[173] See on the Metropolregion Nordwest: http://www.metropolregion-nordwest.de/

[174] See on the respective facts about Bremerhaven: https://www.bremerhaven.de/de/

[175] See on the Gross Regional Product (GRP) of the country states of Germany: https://en.wikipedia.org/wiki/List_of_German_states_by_GRP_per_capita

Figure 18: The Sixteen German Country States (including the country state of Bremen with the two towns Bremen and Bremerhaven)

Source: Via Google Maps

The general trend of waste generation in Bremen as presented in the table below reveals that waste generation declined from 416 kg per capita in 2004 to 320 kg per capita in 2013 in Bremen. This translated to a decline of about 23% in Bremen. It is interesting to note that waste generation in Bremen was declining despite the increase in the standard of living witnessed during the past decade[176] and that the decline was faster than the 7% which were recorded as the average for the whole of Germany (BMU/FEM, 2018). When comparing the waste generation in the country state of Bremen with the average for the whole of Germany it is indicated that the waste generation in Bremen is declining faster than the average for the whole country. For example, the European Environmental Agency (EEA, 2013) shows the development of waste generation per capita in Germany from 2001 to 2010. It reveals that there has been a decrease from 632 kilogram per capita in 2001 to 564 kilogram in 2006. From 2007 to 2009, there has been a minor increase, but the level seems to have been quite constant since 2006. However, the average during the period is more than 550 kg per capita[177].

The 23% reduction in waste generation in Bremen during the period of 2004 to 2013 was due to the higher rate of waste prevention, recycling or reuse during the period. In 2014, Bremen had 15 waste recycling stations, according to MWMAB/Municipal Waste Management Authority Bremen/DBS/EKO Bremen (2013, 2014); there was a budget of €6 million (being equivalent to Naira/N1.2 billion). The table below indicates that waste in public places has declined even by 61%. This can be attributed to the role of proper environmental education, effectiveness of the law prohibiting indiscriminate dumping of refuse in public places, and the provision of containers in which waste can be deposited in public places for effective collection by the waste collectors. Available information (from MWMAB/Municipal Waste Management Authority Bremen/DBS/EKO Bremen, 2013, 2014) indicates that the Country State of Bremen spent €1.41 million (this is about N280 Million Naira) for the provision of waste containers in public places

[176]. The GDP of Bremen has increased from €27.286 billion in 2007 to €33.662 billion in 2017; see: https://de.statista.com/statistik/daten/studie/5013/umfrage/entwicklung-des-bruttoinlandsprodukts-von-bremen-seit-1970/

[177] The total German generation of waste decreased from 52.1 million tonnes in 2001 to 46.4 million tonnes in 2006. The generation increased to 48.5 million tonnes in 2009, but then again decreased from 2009 to 2010 to 47.7 million tonnes (EEA/European Environmental Agency, 2013).

in Bremen in 2014. Metal as waste was reduced by 41%, as indicated in the table 2 below; this is a result of the drive and the effort to increase the re-using and the re-cycling of metal through various medium and large-scale firms. The amount of pollutants was also reduced by 41%. This was due to the now greater consciousness of environmental damage of pollutants among the people; hence the waste management authority devised appropriate means of disposing them. In some cases, they can export them to some countries that can properly handle the pollutants. Commercial Waste, Paper and Cardboards, Residual Waste, and Bio-waste declined by 22%, 13%, 11%, and 9% respectively during the period. This can be attributed to the effective management of waste through waste prevention, re-cycling and re-using during the period under consideration. However, Electrical waste, Textile waste and Garden waste witnessed increases of 61%, 7% and 6% respectively as revealed in the table below. This is a pointer to areas of waste management where Bremen needs to improve its performance. Spectacular are the changes in few categories: commercial waste (-); electrical waste (+); metals (-); pollutants (-); and waste in public places (-). The only category with a (+) is electric waste, so that policies on this category need immediate further action.

Table 2: Trend in Types of Waste Generated in Bremen 2004 to 2013 in 1,000 tonnes

Waste	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	% Change over the entire period 2004-2013
Residual Waste	100.88	99.55	97.87	97.44	95.68	95.40	94.19	94.63	91.77	90.24	-11
Commercial Waste	10.88	12.79	17.49	12.73	11.71	11.65	11.44	10.53	9.32	8.47	-22
Paper & Cardboards	43.01	40.70	40.67	41.14	40.25	38.61	38.10	38.84	37.22	37.22	-13
Garden Waste	26.60	29.19	28.22	29.25	29.62	29.72	28.58	28.77	29.32	28.07	+6
Bio-Waste	24.06	23.72	23.32	23.94	23.11	23.14	22.08	22.78	22.21	21.81	-9
Bulk Waste	23.88	25.92	26.88	26.31	25.42	26.25	24.17	24.53	22.91	22.39	-6

Electrical Waste	**1.43**	**1.48**	**2.18**	**2.52**	**2.85**	**3.17**	**2.88**	**2.96**	**2.57**	**2.30**	**+61**
Metals	**2.06**	**1.76**	**1.48**	**1.32**	**1.43**	**1.74**	**1.54**	**1.39**	**1.26**	**1.21**	**-41**
Textiles	**2.34**	**2.06**	**1.95**	**2.09**	**2.44**	**2.51**	**2.45**	**2.65**	**2.48**	**2.50**	**+7**
Plastic Waste[178]	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Pollutants	**177**	**185**	**144**	**129**	**128**	**129**	**110**	**108**	**101**	**104**	**-41**
Waste in Public Places	**3.70**	**2.78**	**2.38**	**2.25**	**2.02**	**1.93**	**1.89**	**1.94**	**1.81**	**1.44**	**-61**
Total	**415.84**	**424.95**	**386.44**	**367.99**	**362.53**	**363.12**	**337.32**	**337.02**	**321.87**	**319.65**	**-23**

Source: MWMAB/Municipal Waste Management Authority Bremen/DBS/EKO Bremen, 2013, 2014

The table 2 above also shows where innovations still should be promoted. It is made clear that innovations are specific for the twelve categories of waste. Commercial waste is different from residual waste; electric waste is different from bulk waste; waste in public places is different from bulk waste and residual waste; metals and textiles are different from residual waste and from commercial waste. An integrated innovation strategy needs to consider these differences, and the German Waste Management Strategy (BMU/FEM, 2018) shows that these differences in approach are seen by policymakers at all governance levels. A stakeholder approach is of importance for most of these categories, and such an approach is widely shared now. A stakeholder approach incorporates all major public and private actors (policymakers, companies, government agencies, R&D institutions, and professional organizations, etc). The lead role in such stakeholder ventures can be different: either by government offices or by private actors or

[178] There is provision to return the empty plastic bottles to supermarkets where you will be paid 25 cent per bottle. This is another measure to reduce waste production in the country. However, this system of disposing empty bottles is different from the general waste management system in Germany. The Dual System (Duales System) is organizing the recycling of PET (Polyethylenterephthalat) bottles. See on the waste packaging system „Der Grüne Punkt/Das Duale System“: https://www.gruener-punkt.de/

even by research organizations; important is the acceptance of the lead role by the members of the club. A good example is the Recycling Industry Technology Initiative with a lead role of the Federal Environment Ministry (FEM).

9.2 Financing Waste Management in Bremen, Germany and the Role of Institutional Transitions

In order to find solutions to improve waste management in Germany, innovative waste management systems were established. These systems are based on lock gates for waste containers.[179] The principal goals for the implementation of a lock gate system are different: reduction of the costs of waste management; reduction of residual waste; an increase in the quantity of dry recyclables; and a better separation of different fractions (residual waste, dry recyclables, compostable waste). The possibilities that such systems give for setting waste fees are important. It is possible to work according to the polluter-pays-principle (depending on the amount of waste) and to ensure transparency in the calculation of the waste fees; thereby, a rationalization of the waste collection system is possible. Economic incentives for ecological and waste management objectives can be installed. There is a variety of "lock gate systems" in Germany, which have been tested or installed within the recent years. Two of them are first, the IPW (Industrial Park Walsrode) Centre system and second, a simple mechanical lock gate system. The simple mechanical lock gate system is common at the household levels. The waste fees within the mechanical lock gate system are calculated depending on the volume of the waste. The lock gate, which is totally mechanical, can be simply installed at (already existing) containers. Another kind of lock gate system involved is the use of plastic bags for light weight packaging (plastic). The plastic bags are sold to the households together with a ticket and can be returned and emptied into the container only at a certain time. The IPW (Industrial Park Walsrode) system is based on medium-sized contractors with very flexible collecting arrangements.[180] The IPW is described as follows: "The Industrial Park Walsrode is one of the most prestigious and important sites of cellulose chemistry in the world. It offers excellent

[179] Lock gates allow an exclusion from being defined as waste and excluding those who are not entitled to place waste in containers so that billing and paying is facilitated and so that reuses and recycling activities are possible; see: https://www.golegal.co.za/waste-economy-manufacturers/; and: https://moba-automation.com/machine-applications/garbage-gates-waste-chutes/keymaster-iii-m/; Using RFID identification devices and transponders helps to manage the system.

[180] See about the IPW system: http://www.industriepark-walsrode.de/entsorgung.html?&L=1

qualities for plastics processing companies and production companies based on renewable raw materials. Engineering service providers, mechanical engineers and the food industry also find excellent conditions at the location. The Industrial Park is fully developed and provides a completely expanded infrastructure with various material media streams. The largest companies at the site are DOW Deutschland Anlagengesellschaft[181], Wipak Walsrode GmbH[182] and Walsroder Casings GmbH[183]." So, as the citation from the homepage indicates, the type of companies and the structure of production at the IPW determine the special focus on waste management and explain the necessity of lock gate systems.[184]

Waste management is capital-intensive in Germany. For example, the municipal waste management authority in Bremen spent more than 55 million Euros on waste management in 2014 as presented in the table on the waste management budget below. The 55.26 million Euros spent on waste management in Bremen translate into about 0.20% of the GDP of the Country State of Bremen of €28.58 billion in 2014. The table below shows that the most expensive cost item in waste management in Bremen was caring for residual waste. This is a type of waste that may need more sorting after collection from households and industries; the rest of the waste from residual waste that cannot be sorted out is then incinerated. Since waste management is an expensive activity, the users of the facilities are charged user fees which are presented in the table below. The essence of the fees charged by the waste management authority of Bremen is to fully recover the 55.26 Million Euros spent for waste management during the year, as part of the budget policy of the independent waste management authority. The major activities on which the money is spent are for collection; implementation of the recycling-law in terms of recycling and cleaning; providing for the waste management infrastructure; waste consulting; waste disposal; etc, as presented in the table 3 below.

Table 3: Municipal Waste Management Budget in Bremen (Germany) in 2014

[181] See on Dow in Germany: https://de.dow.com/de-de
[182] See: https://www.wipak.com/de/kontaktieren-sie-uns/produktionsbetriebe
[183] See: https://www.walsroder.com/de/
[184] See on the IPW: http://www.deltaland.de/english/industrial-park.html

Collection, Recycling and Disposal	
Types of Waste	Million Euros
Residual Waste	20.60
Bio-waste	6.71
Paper and cardboard	2.72
Bulk waste	7.04
Garden Waste	1.26
Christmas Trees	0.17
Pollutants	0.48
Construction/Building Waste	0.38
Sub Total	39.36
Cleaning	
Illegal waste deposits	0.61
Scrap cars and scrap bicycles	0.06
Public waste containers	1.41
Infrastructure and Service	
Fees Management, Waste Consulting, telephonic customer centres and commercial services	4.95
Collection, Recycling and Disposal	
Operation of 15 recycling stations	5.59
Operation of 288 container places	0.50
Others	1.74
Implementation of the recycling-law at all levels of the hierarchy of objectives	1.04
Total	55.26

Source: MWMAB/Municipal Waste Management Authority Bremen/DBS/EKO Bremen, 2013, 2014

In Germany, waste collection charges on households need to cover the full cost of collection and management of waste. Such tariffs vary considerably between municipalities, depending on the

waste management situation and the services offered to citizens. The table 4 below reveals that the waste collection fees charged in Bremen town are based on first, a fixed charge of 43.26 Euros, second, the volume of containers, third, the maximum number of the people living in the household, fourth, the total number of regular waste collection, and fifth, the fee for any extra waste collection per year. In a case where a household has a 60 litres container, with 2 people living in the household (the average household size in Bremen is 2) and based on a provision for 20 collections per year this will translate to performance fees of 106.40 Euros. The total fees for waste collection by the household, if there is no extra collection during the period, is then 149.66 (106.40 performance fees + 43.26 fixed fee charge) per year. It means that about 150 Euros is paid for waste collection in Bremen during the period under consideration. This translates to about 0.4 % of the per capita GDP of €35,101 for Germany in 2013.[185] If Nigerians are to pay 0.4% of per capita GDP, they will be charged waste collection fees of €3.54 (or 762 Naira) per household with two family members per year. The waste collection charges are paid quarterly during the year in Bremen. If there is one extra waste collection, the total fees charged for waste for the year will become €154.98 (149.66 + 5.32 for one extra collection). However, Nigeria has an average family size of 6; hence, the average household will be paying performance fees of €284.20 and €43.26 fixed fee charge, totalling about 328 Euros, which is approaching 1% of the per capita GDP of €35,101 in Germany in 2013. If Nigerians with a large family size are to pay around 1% of their per capita GDP, they will be charged waste collection fees of 8.86 Euros (1,905 Naira) per year. However, such comparisons are only to give an idea about income and fee relations; the reality is different as the systems are completely different in Germany and Nigeria, especially because of the informal collection and disposal systems. The issue is presented only to show the relevance of a rational fees system which is stimulating proper waste management.

Table 4: The Waste Management Fee Charges in Bremen as at 1 January 2014

Basic fee per unit of usage (43.26 Euros)

[185] See on the data for 2013: https://www.focus-economics.com/country-indicator/germany/gdp-per-capita-EUR

Tonnage	60 Litres	60 Litres	90 Litres	120 Litres	60+120 Litres	240 Litres	770 Litres	1100 Litres
Maximum Number of people in the (households)[186]	1	2	3	4	5	8	38	55
Container volume per week	60 Litres	60 Litres	90 Litres	120 Litres	60+120 Litres	240 Litres	770 Litres	1100 Litres
Performance fee per year	69,16	106,40	147,40	182,20	69,16 + 182,20 = 251.36 Euro	284,20 Euro	1.611,22 Euro	2.084,60 Euro
Number of Collections per year	13	20	20	20	20	20	52	52
Fee for each additional collection	5.32 Euro	5.32 Euro	7.37 Euro	9.11 Euro	5.32 Euro (60 l) 9.11 Euro (120 l)	14.21 Euro		

Source: MWMAB/Municipal Waste Management Authority Bremen/DBS/EKO Bremen, 2013, 2014

It is important to study the structure of the budget for waste management and the fees structure in detail as the budget structure and the fees structure give the frame of the economic incentives system which may translate into a more rational resources use and an ecological behaviour of households and firms. In Bremen, the improvement of the system is continually underway. The

[186] For the waste of "non-personal use units" a fee for each for every 120 square feet of office space is defined by legislation under the system of 'fees for waste management in the city of Bremen'.

recent re-communalization of the waste management system and authority has added a new objective to the established ones – improving the labour conditions of the workers.

10.0 The German Waste Management System in the European Union (EU): The Comparative Ranking of the German Waste Management System and Consequences for Reforms

Various studies highlight the performance of EU countries in terms of waste management systems. Some studies are some years back (BiPRO/Economic Commission, 2012), but are of interest because of the criteria compared; others are more recent (EPRS/European Parliamentary Research Service 2017) but based on many 2012 data and have a different focus on the performance of the waste management systems in the EU, emphasizing the progress towards a circular economy. The ranking of European Union (EU) countries based on the efficiency of their waste management system has ranked Germany third after Austria (1) and Netherlands (1) and Denmark (2) (BiPRO/Economic Commission, 2012). Austria and Netherlands were ranked first, while Denmark was ranked second, and Germany was ranked third; the positions of all the other EU countries are presented in the table 5 below.

Table 5: Ranking of 27 EU Countries in Terms of Waste Management Performance (Croatia not yet included)

Country	Performance Score	Country	Performance Score
Austria	39	Netherlands	39
Denmark	37	Germany	36
Sweden	35	Belgium	34
Latvia	33	Luxemburg	33
United Kingdom	32	Finland	31
France	31	Slovenia	25
Estonia	21	Portugal	21
Hungary	19	Ireland	19
Czech Republic	18	Poland	18
Slovakia	17	Spain	17

Italy	15	Lithuania	14
Cyprus	11	Romania	11
Malta	9	Bulgaria	8
Greece	3		

Source: BiPRO/Economic Commission (2012)

The report commissioned by the European Commission (EC) graded the 27 EU member states (now 28 countries with Croatia) against 18 waste management criteria and ranked them by score (see on these 18 criteria for five categories the situation of Germany in table 6). Five categories of criteria in assessing waste management performance in EU countries were considered: first, the compliance with the waste management hierarchy reflecting the real situation (Category 1.6 Criteria); second, the existence and application of legal and economic instruments to support waste management according to the waste hierarchy (Category 2.3 Criteria); third, the existence and quality of an adequate network of treatment facilities and future planning for municipal waste management (Category 3.5 Criteria); fourth, the fulfilment of the targets for diversion of biodegradable municipal waste from landfills (Category 4.2 Criteria); and fifth, the number of infringement procedures and court cases concerning non-compliance with the EU waste legislation (Category 5.2 Criteria). In almost all the criteria used, Germany scored higher than the average for European Union (EU) Countries as reported in the table below, except in regard of the existence of an own waste prevention programme (WPP) or of equivalent solutions (according to criterion 1.2, so that in this criterion the score value is zero). The best performing countries had some difficulty to decouple the municipal waste generation from households' final consumption expenditure; this is to some extent also a problem for Germany. But this situation may have improved since 2012, although the data for the period from 2012 to 2015 do not give encouraging trends on decoupling of volumes of waste from GDP development (as seen in the report by BMU/FEM 2018, figure 2 on page 9).

Table 6: Overall Scoring of Germany According to the EC Comparative Waste Management Performance Study

Waste Management Performance Criteria	Germany Score	Average Score for EU
Level of decoupling of municipal waste generation from household final consumption expenditure	1.00	1.00
Existence of own waste prevention programme (WPP) or equivalent existence in Waste Management Plan (WMP) or other (environmental) programmes	0	0.74
Amount of municipal waste recycled (material recycling and other forms of recycling including composting)	4.00	2.00
Amount of municipal waste recovered (energy recovery)	2.00	2.00
Amount of municipal waste disposed (deposit onto or into land and incinerated without energy recovery)	4.00	2.00
Development of municipal waste recycling (material recycling and other forms of recycling including composting)	2.00	1.26
Existence of nationwide ban/restrictions for the disposal of municipal waste into landfills	2.00	0.89
Total typical charge for the disposal of municipal waste in a landfill	2.00	1.00
Existence of pay-as-you-throw (PAYT) systems for municipal waste	2.00	0.85
Collection coverage for municipal waste	2.00	1.33
Available treatment capacity for municipal waste in line with the EU waste legislation (including disposal and incineration)	2.00	1.48
Forecast of municipal waste generation and treatment capacity in the WMP	2.00	0.67

Existence and quality of projection of municipal waste generation and treatment in the WMP	1.00	0.48
Compliance of existing landfills for non-hazardous waste with the Landfill Directive	2.00	1.19
Fulfilment of the targets of the Landfill Directive related to biodegradable municipal waste going to landfills	2.00	1.26
Rate of bio-degradable municipal waste going to landfills	2.00	1.00
Number of Infringement Procedures - Waste Framework Directive[187] and Landfill Directive	2.00	1.30
Number of Court Cases - Waste Framework Directive and Landfill Directive	2.00	1.56
Total	36.00	22.00

Source: BiPRO/Economic Commission (2012)

Waste management in Germany can be said to be on the way to become efficient and sustainable. In Germany, recycling has increased from 48 % of municipal solid waste (MSW) generated in 2001 to 62 % in 2010 (EEA/European Environmental Agency, 2013), and this rate has increased to 68% in 2015 (BMU/FEM, 2018). The EU target for 50 % recycling by 2020 has therefore already been met (EEA/European Environmental Agency, 2013). Many factors can be attributed to the success of efficient sustainable waste management in Germany. The latest initiatives are first, the introduction of the so-called recycling bin (Wertstofftonne) that aims to increase the share of recycling of plastics and metals from households[188], and second, the mandatory separate collection of bio-waste by 2015. Germany was the first country in the EU to

[187] The EU Waste Framework Directive defines the basic principles of an environmentally sound management of waste. See: http://ec.europa.eu/environment/waste/framework/index.htm; this Directive is important as it contains basic definitions.

[188] See on the discussion about the Wertstofftonne in Germany: https://www.nabu.de/umwelt-und-ressourcen/abfall-und-recycling/recycling/14906.html; see also: https://www.friesland.de/portal/seiten/gelbe-saecke-gelbe-tonne-oder-wertstofftonne-danke-fuer-ihre-teilnahme-und-ihr-interesse--901001022-20800.html, and: https://www.bund-bremen.net/themen/mensch-und-umwelt/ressourcen-und-abfall/abfall/. The major issue is to increase the overall recycling rate of plastics and metals through the inclusion of non-packaging plastics and metals what is so far not allowed in the yellow bin.

introduce producer responsibility with a packaging waste regulation in 1991. According to this principle, which is a core tenet of the German waste management legislation, the producer of a product is generally responsible for the product when it becomes waste. However, this principle has been implemented only for some product types, such as packaging, waste electric and electronic equipment, vehicles, solvents, waste oil, and batteries. However, there are intentions to broaden the system of producer responsibility.[189]

For waste generated by households, the Recycling Management and Waste Act (Kreislaufwirtschaftsgesetz) of the German Federation assigns responsibility to the local public waste disposal authorities (in most country states these are districts and towns). Their responsibility covers collecting and transporting waste, measures to promote waste prevention and recovery, and planning, constructing and operating waste disposal facilities. Municipalities have more practical tasks such as providing sites for waste collection (EEA/European Environmental Agency, 2009). In the mid-1960s the federal government level and the country states in Germany started to analyse waste disposal practices and disseminated the findings to the municipalities, which were responsible for disposing of municipal waste. Due to a substantial increase in industrial production and private consumption, as a result of economic growth, waste generation grew rapidly at the beginning of the 1970s. At that time, waste was primarily disposed of in 50,000 small dumpsites, and the public policy interest concentrated on them and the need to build appropriate waste management facilities. In the 1990s, Germany was among the first European countries to introduce policies to limit landfilling. Measures applied have included schemes for collecting packaging waste (yellow bin), waste paper (blue bin) and bio-waste (brown bin) separately from residual waste (black bin). As a result, by 1995 Germany already recycled a relatively large proportion of municipal waste and landfilled approximately 40 % of this waste (EEA/European Environmental Agency, 2009). True federalism in the sense of

[189] See: https://www.ecosurety.com/news/germany-proposes-to-extend-producer-obligations-what-you-need-to-know/; see also about the scope of the "producer responsibility principle": www.uncrd.or.jp/content/documents/6549MS-5-P4.pdf

dynamically adapted federalism helps in designing appropriate mechanisms that are relevant to each country state. In Germany, responsibility for waste management and environmental protection is shared between the federal government, the country states, and the local/municipal authorities. This division of labour needs to be adapted continuously to react to the new trends in materials, logistics, communication and awareness. The Federal Ministry for the Environment (FME) sets priorities, participates in the enactment of laws, oversees strategic planning, information and public relations, and defines requirements for waste facilities. Each country state adopts its own waste management act containing supplementary regulations to the federal law, e.g. concerning regional waste management concepts and rules on requirements for disposal. There is no national waste management planning in Germany. Instead, each country state develops a waste management plan for its area (EEA/European Environmental Agency, 2009). The responsibility for the operations and the execution of the laws and regulations is with the local units and the municipalities. Operational activities are highly decentralised, based on the local laws and regulations.

German waste policy follows the EU's waste management order (Europäische Abfallrahmenrichtlinie[190]), with waste prevention as the first priority, followed by material recovery and energy recovery, depending on which is better for the environment. Objectives for managing municipal waste (Siedlungsabfall) also focus on avoiding contamination of waste and ensuring treatment and landfilling of waste that is not recovered. Recycling aids in diverting waste from landfills by limiting the organic content of the waste. A landfill ban was introduced to achieve this goal. It was introduced in two steps and by using three pieces of legislation because the initial statute contained severe loopholes. The first step was an administrative regulation (TASi) in 1993[191], which limited the organic content in waste going to landfills to less than 3 % of total organic carbon (TOC). Achieving such a low organic content necessitated thermal treatment of the waste. Separate collection of bio-waste and paper is also regulated

[190] See the important changes of 2018 to the Waste Framework Directive (WFD) and to other four Directives: https://www.karlsruhe.ihk.de/innovation/umwelt/Abfall/Aktuelle_Informationen/die-neue-eu-abfallrahmenrichtlinie/4160290. Important changes with regard of definitions took place and clarifications on the "waste management hierarchy" were made.

[191] See on the regulations of TASi/Technische Anleitung Siedlungsabfall: https://www.rh-entsorgung.de/de/Unternehmen/Rechtliche-Grundlagen/.../tasi-ges.pdf, and: http://de.wikipedia.org/wiki/TA_Siedlungsabfall

mainly through legislative measures. In 1983, the Country State of Hessen initiated the separate collection of bio-waste to divert waste from landfills. Between 1985 and 1993 the number of inhabitants having a collection system for bio-waste has increased from 400,000 to 7.6 million (EEA/European Environmental Agency, 2009). Packaging waste is regulated by the Packaging Ordinance (1991), which introduced producer responsibility. In this case, that implies that producers and retailers are obliged to take back used packages and to contribute to their further management. The new Waste Framework Directive of the EU is since 2018 in force and has sharper definitions and more instruments to give economic and other incentives for change. The 2018 Circular Economy Package of the EU is seen as an instrument to make the EU to consolidate its position as a leader in waste management.[192]

Germany was among the first European countries to introduce policies to limit landfilling in the 1990s. Measures included schemes for collecting packaging waste, bio-waste and waste paper separately. The result of this was that by 2001 Germany already recycled about 48% of municipal waste, whereas approximately 25% was landfilled and 22 % was incinerated. The municipal waste that went to landfilling in 2017 has been reduced to about 11% in 2017 (BMU/FEM, 2018). Germany is presented as a leader in waste management in the EU, as the European Commission study of 2012 (BiPRO/Economic Commission, 2012) has shown. In regard of the size of Germany this can be supported as the other leading countries in waste management (Austria, Netherlands and Denmark) are smaller-sized countries. In all the 18 criteria used in the study, Germany scored higher than the average score for European Union (EU) countries except in the field of existence of an own waste prevention programme. However, with the level of improvement that has taken place in waste prevention in Germany in the recent years, a new ranking may take Germany to a higher ranking in the ladder.

But there are other evaluations done by EU bodies, such as the European Parliamentary Research Service (EPRS); their study investigates in detail the process towards a circular economy in the EU countries. In comparing this direction for the EU countries, we see that Germany is not so

[192] See on these changes to the various Waste Management Directives: https://www.globalelr.com/2018/07/the-eu-adopts-four-directives-to-solidify-europes-leading-position-in-waste-management/

well placed (see EPRS/European Parliamentary Research Service, 2017). The Annex 5 (EPRS 2017, page 128) shows in a summary table for EU-28 member states some weaknesses of Germany in terms of the "Performance of EU-28 Member States in 2012 against the proposed EU Circular Economy Package 2030 targets". Whereas in municipal waste, there is a good position of Germany, in Packaging Materials there are various bad points (on glass, wood and plastic), meaning that the 2030 targets for packaging materials were not met in 2012 (in contrast to Belgium which has already achieved these targets, but is at disadvantage to Germany for municipal waste targets). Chapter 3 on current performance, indicators and trends gives also a mixed picture for Germany (EPRS 2017, pages 31ff), but major data are for 2012. Municipal waste generation in Germany is higher than in most other EU countries (despite of the decoupling philosophy of waste volumes in relation to GDP). Per capita waste between 2005 and 2015 is growing, meaning that there is no trend towards waste prevention. United Kingdom and Netherlands have done much better. Germany is worse than the EU Average. Germany is a leader in terms of the landfills target of the EU (not more than 10% of municipal waste is landfilled). Germany is the number one. Treatment of plastics waste shows that Germany is not only with a ban on landfills, but also has a high rate of recycling and of energy recovery. UK, on the contrary, has a very high disposal rate in landfills. The breakdown of recyclable materials and bio-waste collected separately and then brought to landfills in 2012 shows that Germany is a significant contributor for ferrous metals waste, for glass wastes, France is a very important contributor to landfills for separately collected recyclable materials and biowaste. Germany is well placed for municipal waste. The 2030 target of the EU Circular Economy Package of 65% for reuse and recycling (material recycling and composting and digestion) was already reached in 2012. But, more than 30% of the municipal waste were incinerated, with a high share of it not for energy recovery but for disposal. Denmark and Sweden have a higher rate of municipal waste incinerated, but only for energy recovery. Comparing the performance of municipal waste generation and recycling shows that Germany is well placed in terms of recycling (as a proxy of effective waste management), but not so much in terms of waste generation (as the EU average of waste generated is surpassed). UK is doing more than Germany for waste prevention, but less on recycling. Packaging recycling achievements show that Germany is not a leading country in any category (glass, metallic, paper & cardboard, wood and plastic). Czech Republic and

Slovakia are leading in plastics packaging recycling. Belgium and Ireland are leading for the total of recycled packaging materials.

It is obvious that Germany can learn from many other EU countries, especially on waste prevention but also no recycling and waste management policies. Germany is relatively weak on waste prevention and relatively strong on recycling. Policies, technologies and cases should be compared and may help to identify new avenues for change. A major problem is the lack of comparative data, so that we will rely on past data for the many years of policymaking. In a study for 2017 we have data for the EU-28 from the year 2012 at best. The EU is improving the system of data collection by many means (Directives, Data Processing, Research, Communication, etc.). Nigeria can learn from the EU-28 process of improving waste management. Nigeria has 36 states in the Federation, and as a member of ECOWAS Nigeria is also interested to aim at improvements of waste management. Nigeria is also considered as a federation in search of federalism.[193] This is most evident in concerns of environment protection and waste management.

11.0 Towards an Integrated Sustainable Waste Management (ISWM) System: Practical Lessons for Nigeria from the German Waste Management System

The study reveals that Germany (especially the case of Bremen town and the country state of Bremen) operates waste management systems which ensure an efficient waste collection, storage, transportation and disposal while minimizing the impacts of disposal on the environment. In addition, there is emphasis and focus on waste prevention, sorting, re-cycling and re-using, including other practices which help to save waste management costs. The waste management system in Germany (in particular in Bremen) is sustainable, because waste management systems in Germany aim at reducing the quantity of natural resources consumed by ensuring that any resources already taken from nature are re-used many times and that the amount of residual waste produced is kept to a minimum and treated in an environmentally safe

[193] See on this discussion: http://50shadesoffederalism.com/case-studies/nigeria-federation-search-federalism/

way. Although this is the general picture, the study has revealed some weaknesses, especially with regard of waste prevention. In terms of waste prevention Germany is not a leader, but in regard of recycling it is. The comparison with waste management systems of other EU countries shows that Germany can benefit from studying other countries' systems carefully. Although the EU is a learning community, the study shows also that much more exchange of solutions and practices is possible. The EU Circular Economy Package is a great achievement and recently new definitions for waste management have made it more applicable to the great number of member countries. The whole EU process of formulating regulations and directives which are binding the member countries is of relevance for the federation of Nigeria and for the role of Nigeria in the ECOWAS integration process. Nigeria with its 36 states can benefit from the experiences of the EU-28 policy process, although the structure of waste management systems in Nigeria is completely different. Informal actors play a huge role in Nigeria and the cooperation with formal institutions and stakeholders leads to frictions and adjustment problems.

The waste management system in Germany is also effective because the responsibility for waste management and environmental protection is shared between the Federal Government, the 16 Country States and the local/municipal authorities. The Federal Ministry for the Environment (FME) sets priorities, participates in the enactment of laws, oversees strategic planning, spreads information and is active in public relations, and defines requirements for waste treatment facilities. Each Country State, however, adopts its own waste management act containing supplementary regulations to the national/federal law. The local/municipal level is responsible for all executive issues, based on local laws and regulations. The execution of tasks can therefore be quite different from one locality to the other – in terms of regulations, fees, organization structures, and waste management value chains. For Nigeria, it is interesting to learn from the German system about the division of competences and tasks between the Federation, the States and the Municipal/Local level. Federal laws and regulations in Nigeria are not translated into executive decisions at State and Municipal/Local levels. In the EU and in Germany the Circular Economy is the guiding principle of all regulations, and from time to time adjustments are made to clarify the principle of a Circular Economy by new definitions, new strategies, new policies and new instruments. In Nigeria, the municipal/local and state-level stakeholders in Lagos State

are working under different conditions. Federal laws and regulations have relevance, but the conditions at state-level determine the policy space (in regard of resources, administrative capacity, skills available, degree of formal and informal institutions, etc.). It is necessary to look from the situation in the country state upwards to the impact from the federation to understand the constraints for improving performance in waste management.

The efficient waste management system in Germany (in particular of Bremen) is evidenced by the fact that waste generation declined from 416 kg per capita in 2004 to 320 kg per capita in 2013 in Bremen. The 23% reduction in waste generation in Bremen during the decade can be attributed to the fact that a much higher share of the waste was prevented, recycled or reused during the period. But, the situation in the country state of Bremen ("Stadtstaat") may be different from country states with a great area surrounding the cities ("Flächenstaaten)". In the country state of Bremen achievements were made possible also because the geographical area is small and based on two cities, that institutions and public offices are near to each other and visible for everybody, and that public awareness about waste management is relatively high. All this has facilitated the effective implementation of waste management laws. The financial commitment for municipal waste management of about 0.20% of the GDP is limited (and all the costs for municipal waste are fully recovered), and the financial commitment of the households of between 0.5% and 1% of their per capita income for waste management (according to small household size and large household size respectively) is acceptable. There is a proper cooperation of municipal waste management authorities with private companies (municipal institutions and private companies are partners in the company "Die Bremer Stadtreinigung" with a share of around 50% each). The municipality of Bremen has moved to re-communalization to strengthen the public control of waste management; intention is also to spread innovations in waste management so that economic, social, logistical and ecological innovations are promoted. The study indicates that, in Germany, recycling has increased from 48 % of municipal waste generated in 2001 to 68 % in 2015. The EU target for a 50 % recycling rate for all EU countries by 2020 has therefore already been met in Germany. Now the EU is moving to more ambitious 2030 targets. Many factors can be attributed to the success of efficient waste management in Germany. The latest initiatives are the introduction of the so-called

recycling bin (Wertstofftonne) that aims to increase the recycling of plastics and metals from households (beyond the packaging waste component), and the mandatory separate collection of bio-waste by 2015 (what is important for economic, ecological and health reasons). Germany occupies a lead position in EU rankings of waste management performance; it has the third position in the important European Commission (EC) ranking of EU countries during the last full assessment, but the results show also weaknesses when comparisons are made with other EU countries, especially in regard of waste prevention and landfilling of certain separately collected types of waste (beside of municipal waste). The modern and innovative equipment that is currently used for waste collection and treatment in Germany will be an important contributory factor that will enhance the competitive position of Germany among the EU countries and will significantly improve the success rate being recorded in waste management in Germany. Also, the competitive position of German firms on the world market in the field of environment protection and waste management will be further strengthened. For Nigeria, it is important to learn from the practices of other States and Countries about pragmatic ways to handle waste; rankings and peer reviews may be important tools to gain such insights. The professional community and the capacity of firms is there; Nigeria has a great human resource and entrepreneurial base which should be better used. The case of Lagos State reveals that a more self-conscious attitude is needed; Nigeria can do it on their own ideas and resources without recourse to assistance from other partners (donors' funds and imported expertise). The case of Lagos State also shows that own solutions are important to solve the waste management problems; it is not appropriate to import ideas for reorganizing local/municipal institutions and programmes. The many innovative projects in Lagos State give an example of the capacity to deliver on waste management under conditions of large urbanized areas with high population pressure, increasing social and ethnic divisions, and strong formal and informal sector industrial activities on the base of a diversified economy.

This study shows that sustainable, efficient and integrated waste management can as well be achieved in Nigeria if there is a proper plan, an effective environmental policy, and a working cooperation between Government and the Citizens. Adequate legal and appropriate constitutional/administrative frameworks should be in place that could be used as tools for

championing environmental-sound and economical-efficient waste management. Now, such frameworks are not enforced due to either negligence of the assigned Actors or due to poor funding by the Government. The political will is needed to put in place the necessary technological and economic resources in Nigeria for establishing and continuously modernizing such a waste management system. However, Nigeria can learn from Germany the mechanisms for effective waste management practices, for coherent waste policy formulation, and for determined waste policy implementation. For an effective integrated waste management system to be experienced in Nigeria, a policy framework[194] needs to be put in place which will drastically reduce the harmful impact of waste on health and the environment. Moreover, it is important to set the following objectives as a base of focus in the policy framework at the federal, state and municipal/local levels:

i. To prevent the rate at which waste is being generated.
ii. To promote and encourage the re-use of waste.
iii. To promote full recovery of waste and the recycling of materials.
iv. To promote the use of waste that is recyclable for energy.
v. To ensure a proper disposal and treatment of waste in order to prevent hazardous impacts.
vi. To embark on a Zero Waste agenda at all levels.
vii. To install monitoring teams to measure progress and results achieved.

The major challenge in Nigeria is the attitude of dwellers towards waste disposal; about 66% of waste is being disposed improperly (Opeyemi, 2012). Illicit waste disposal is rampant among Nigerians; there is dumping of garbage in valleys or swamps and the disposal of untreated industrial waste to the public drainages. The flooding of canals in the rainy season means that

[194] Although the Nigerian Government recognizes the importance of legislation as an instrument for ensuring an effective and integrated waste management system, the major legislation that could enhance effective waste management activities within the society was not enacted. Moreover, those that were promulgated are not effectively enforced among the actors due to many factors, for example: corruption within the system, negligence of the public, lack of awareness or campaign, poverty, illiteracy, lack of finance by the federal and the state governments, just to name a few. Therefore, for sound, healthy and greener environment structures to be experienced in Nigeria, new plans, new strategies and new policies need to be implemented effectively. Where necessary, revision should be made on the Waste Management Act whereby all the necessary bodies and stakeholders (the municipalities, the product manufacturer organizations, the waste producers, the private waste management companies, and the organizations of waste advisory services) will recognize their duties and priorities.

waste is spread widely in the city and in outside areas. Sometimes private actors (as, for example, cart pushers) are also major contributors, as waste collected by these private actors is disposed to land sites or to any available open field without separation (especially when they are interested only in specific items from the waste); this is causing hazard to both humans and to the environment at the long run. Sometimes they burn such waste at late hours in the night to avoid harassment by law enforcement agencies. It is disappointing to observe such inappropriate habits, as people are living around and act as contributors to such unhealthy attitudes by dumping their own waste also to avoid paying waste fees by waste collectors. The lack of a waste management infrastructure (a good road network and appropriate facilities for waste disposal, collection, recovery and treatment) leads then to the haphazard waste disposal on land, farms, surface waters, and swamps. Such attitudes have unhealthy consequences for all human beings and for the environment, and awareness campaigns are needed at all governance levels and in all possible forms; media, TV, radio and local councils have a role to play in creating awareness. Beside of creating awareness it is necessary to facilitate the transition to another behaviour; the people must be able to follow the regulations for waste management, to pay for the support of waste collectors, to find waste dumping sites which have a minimal infrastructure, etc. Instead of creating such an environment, illegal waste dumping impacts negatively on the quality of water, farmland, and the health of the people. Nigeria can learn from the experiences of some of the EU-28 member countries which had to start near zero in their waste management policies (such countries as Bulgaria, Romania, Cyprus, Malta, and others). In the EU accession process and later as members of the EU they were monitored and evaluated also in regard of following the EU waste management directives and they were supported in the process of developing national waste management laws on this basis. The assessment of various criteria for improvements of the waste management systems has helped in this process.

Creating proper awareness of the citizens toward the economic value of the waste produced by them can contribute immensely to the proper handling of waste by the policymakers, and it will help to create a greener environment, employment opportunities and better health conditions and to generate revenues to the government which can be used for waste management facilities. In order to make the society take full responsibilities of waste generated and of the disposal

challenges, government and other agencies need to help in re-orientating and educating the populace on the importance to generate less waste and to introduce appropriate methods to dispose waste produced without any damage to the environment. Such attitudes will produce a sound and healthy environment and as well will promote sustainable development for the people of Nigeria. The main purpose of waste management and environmental management plans is to reduce the adverse effects on the health situation and on the environment. Such plans will also in Nigeria lead to specific forms of integrated solid waste management (ISWM), although being different from the ways this is done in EU countries and in other developed countries.

The following measures are the precautions that can be adopted in Nigeria during collection and disposal of waste:

i. Closed containers or bins should be used in order to prevent the exposure of waste and the spreading of diseases through flies and other dangerous insects; examples for Lagos State show that this is already possible. But such equipment is needed not only in the centre of the city, but also in sub-urban areas. Slum areas should not be forgotten from the waste management authorities. The case of Lagos shows that a policy change is needed in this regard.

ii. Safety materials and proper training of safe working conditions should be provided for the waste management workers. Too often the modern equipment for waste collection and treatment is not accompanied by manuals which are used to train the workers in handling the devices. The support material to train the understanding of the new equipment is intended to take care for the waste management workers, but it is not properly used. It is necessary to combine theoretical and practical knowledge. This is especially important for workers who are collecting hazardous waste, bio-waste, bulk waste, and medical waste.

iii. Disposal sites should be properly covered with soil and other materials in order to prevent the breeding of disease vectors and the escape of gases of decomposition; to minimize the leaching; to suppress the foul odour; and to provide for a better aesthetics environment. All this can only be effectively done with the support of scientists and technicians who know about the best means to protect the environment and the health situation.

iv. Regular monitoring of carbon monoxide, methane and hydrogen sulphide should be carried out to check the emissions of such pollutants. Proper sorting of bio-waste from the

disposed waste will reduce the amount of carbon monoxide, methane and hydrogen sulphide that will be emitted into the environment. Also, in this case the support by a scientific and technical infrastructure is needed. The scientific and technical infrastructure should be near the disposal sites and the experts should cooperate closely with the basic support units in the public waste management and environment offices.

v. It is possible to learn from the EU waste management systems in regard of all these measures. Nigeria can benefit from EU guidelines and practices to protect health conditions, waste management workers, to protect the quality of groundwater and land, and to protect from emissions of pollutants. The EU-28 has different environmental, agrarian and economic conditions, so that Nigeria can find bilateral partners on most issues being relevant in one of the country states of the Federation of Nigeria.

The Nigerian waste management system should be modernized to ensure efficient waste collection, storage, transportation and disposal with a minimum of negative effects on the environment. The amount of landfilled bio-degradable waste must significantly be reduced, and drastic measures need to be taken to increase the recovery rates of methane which is generated at landfills. Moreover, there should be an increase in the taxes paid by the users of waste-generating sectors and of the fees for the services of the waste management systems. Taxes and fees need to be related to the capacity to pay of the income groups, and there should be specific groups of users with different (subsidized/privileged/progressive) rates of taxes and fees. Only waste that is properly treated, waste that is not harmful to the environment, and waste for which the recycling means are not yet available due to technology constraints should be allowed in the landfill sites. The usage of waste-based fertilizer material in Landscaping and Agriculture should be considered and promoted in Nigeria. Also, in this regard the practices of countries in the EU-28 may be relevant. Organic fertilizer is an issue to be considered by EU-28 and Nigeria. ECOFI (European Consortium of the Organic Based Fertilizer Industry)[195] is an example of a potentially beneficial cooperation between EU-28 countries and Nigeria. ECOFI cares for organic fertilizer, organo-mineral fertilizer and organic soil improvers. The EU's smart, sustainable and inclusive growth strategy Europe 2020 meets also ambitions of Nigeria's agricultural transformation and

[195] See on ECOFI: http://www.ecofi.info/

growth acceleration strategy. Organic fertilizers/environment-friendly fertilizers are now brought into the new regulations of the Circular Economy Package.[196] Nigeria with its great potential of organic fertilisers can benefit from these new developments in the EU-28, as the draft regulations of the EU are based on the rich knowledge stock from researchers, manufacturers, farmers and agricultural practitioners.

Nigeria's town planners need to re-examine their objectives and should try to address the issue of waste management generation and to make provision for appropriate waste centres in the municipals where people can drop their waste for municipal waste management teams (public or/and private) to pick up for proper recycling/disposal. The towns and cities should be well planned so that the waste collectors will be able to access the houses where waste needs to be collected. If waste management issues are taken and handled properly, then the waste generated would be another source of generating revenue which will enhance the economy and as well contribute to the standard of living of the citizens by creating a healthy environment and employment opportunities. In addition, there should be emphasis and focus on waste sorting by users. This can start by the provision of different waste bins, bags/containers for sorted waste at the users' places or at the houses. The case of Bremen reveals that behind the coloured bins/bags are different laws and acts; the documentation for the bins and bags is impressive, and waste management plans, waste management budgets/fees and waste management balance sheets add to the whole process of waste management. The case of Bremen also shows that continuous adjustments to the plans, budgets and balance sheets must take place. While Bremen is competing with other country states, Germany is competing in the context of the EU-28 countries.

For an effective and sound waste management system to be experienced in Nigeria, a functioning relationship between local, state and central governments is needed, but also the participation of the citizens in the process of policy making should be allowed and facilitated. In such a manner,

[196] See: http://www.ecofi.info/2018/10/organic-fertilizers-in-eu-regulation/, and: https://www.consilium.europa.eu/en/press/press-releases/2018/12/12/eu-moves-towards-more-environment-friendly-fertilisers/

transparency in waste management will be made possible and experienced. On the other hand, those who contribute negatively to the development of the country in terms of waste management through illegal disposal activities or by cheating the public should be brought to justice so that future selfish and environmental damaging attitudes will be corrected. In Bremen and in Germany the fines for illegal activities on waste are already high and will be further increased. This is necessary for safety of workers, for the health of the citizens, and for the future supplies of hygienic water from various sources. It is obvious that the whole waste management value chain has to be safe so that negative effects on the people are avoided.

Recycling can be promoted by the provision of recycling stations by the waste management actors in Nigeria. There is a lot of discussion about new projects, but too often not more than pre-feasibility studies come out from this. It seems that each state in Nigeria should have their own recycling strategy and a strategy for building central recycling stations. For example, Bremen alone has 15 recycling stations. Re-use can be encouraged by paying for the returned used bottles and plastics materials. This can only work with the cooperation of the private firms. The producer responsibility system (PRS) is of great importance, but still there are many limitations to the working of this principle. The Extended Producer Responsibility (EPR) principle is now a cornerstone of waste management policies in Europe.[197] Not only the safety of the product and the safety of the working conditions matters, but also the fate of the packaging waste after the use of the product. In EU-28 countries different approaches are used to conform to the EPR principle; Nigeria can learn from these alternatives to apply in the 36 states of the federation quite different models of the EPR principle. This implies that government in EU-28 countries and in Nigeria needs to carry private firms along in the management of packaging waste. In the case of Germany (Bremen), the involvement of private firms is at high levels; the recycling rate of packaging waste is about 97% (see BMU/FEM 2018, page 21). Up to 68% of the typical household waste is recycled in Germany, but waste prevention is not advancing as fast. Such high recycling rates are based on a deep cooperation with the private sector. This cooperation is lacking in Nigeria, and this situation must change for efficient and effective waste management in Nigeria; preliminary studies on the issue, such as for private sector involvement for waste

[197] See: https://europen-packaging.eu/policy/9-extended-producer-responsibility.html

management in Oyo State (Ibadan), give hope that in some states progress can be made (see World Bank 2014).[198] It is proposed for Ibadan, the capital city of Oyo State, to strengthen the control of the private sector, to streamline and extend the revenue system for services from the actors waste management value chain, and to improve the contracts between the public authorities and the private firms in the waste management value chain.

Inability and unwillingness of the people to pay for waste management services is a major problem befalling Nigeria. If every household makes it a priority to pay for the services rendered by the waste management system, then Nigeria will be able to maintain its beautiful landscape, and everyone will be able live a healthy life. The activities provided by the waste management system can be sustained, and the continuous effort to maintain a greener environment will be encouraged at all time. Moreover, it will be an avenue for the Government to generate revenue, to provide more employment, and at the same time to create social amenities within the city. There is a need for a financial commitment of about 0.20% of GDP on waste management in Nigeria. This capital outlay can easily be recovered as it is done in Germany. Going by the waste management financing system, the small household should be ready to use about 0.5% of their annual income as waste management fees, while the large household size will be committing 1% of their income for the same purpose. This arrangement will ensure a full cost recovery of waste management (if the contracts are rational, if the equipment is in place, if the human skills are used, and if damages to the environment can be repaired). It will, however, not be easy to achieve the same result in terms of waste management as in Bremen with the share of 0.5% to 1% of the household income. The use of modern and innovative equipment that is currently used for waste collection and treatment in Germany is highly recommended for Nigeria, but it will work optimally only if the formal and informal waste management systems are coordinated and if the equipment is properly maintained and used. A workable composting system, from where most of the fertilizer used in Germany is being derived, is urgently needed in Nigeria. A list of targets and goals to achieve effective waste management can be set for all the capital cities in Nigeria, and the benchmarks set can be used to measure the progress of waste management in each state and for all the capital cities. Finally, true federalism is an important anchor on which

[198] See about the study World Bank 2014 also the PPIAF (Public-Private Infrastructure Advisory Facility) for the Oyo State Government 2017.

waste management is based in Germany, and this form of federalism is also important for Nigeria. The extended producer responsibility (EPR) system is equally important so that the producers of products need to care for the waste after the end of life of the services provided by these products. All economic actors can be made responsible for their products and for their waste after the economic life of the products. Also, this is a novel aspect for Nigeria.

Interestingly, it was found that for the EU-28 countries (or then the EU-27 countries) and for the Federation of Nigeria there are similar issues to be tackled to align waste prevention, circular economy and waste management objectives. A close cooperation between the waste industry and the enterprises engaged in the circular economy business models are requested. Technological developments are of key importance for the five major waste streams being of relevance for the circular economy approach (municipal waste, packaging waste, food waste, bio-waste, and critical raw materials/CRMs). Technological developments, innovation responses and policies to create high-skilled and low-skilled employment for these five streams of waste are important for the EU countries and for Nigeria (see EPRS 2017 on details). The circular economy approach may provide a methodological base to find appropriate solutions for all the five major waste streams. We know that Germany is still far away from a real circular economy approach. Germany is focussing on improved waste management, but a real circular economy means the redesign of products and the inclusion of new actors who are willing to create long-lived, repairable, and 100 percent cyclable products (Wilts 2016). A circular economy does not emerge on its own, but needs supporters at all policy levels, and a new mix of instruments is requested. Insofar, Germany, the other EU countries and Nigeria are in the same boat, as all these countries need to restart on the way to a real circular economy. Technical innovations are only a part of the story, as fundamental systems innovations are requested from the outset to move to the circular economy. The waste business in Germany with around €50 billion annually has a lot of self-interest to keep it going and growing, and such a model may also be of interest to business leaders in Nigeria.

Too many donors, firms and cooperation partners being active in Nigeria emphasize this waste business model rather than the circular economy business model. But a circular economy

business model is different. This circular economy business model will affect all sectors, products, services and firms leading to new business opportunities, while the classical waste business model is then declining in importance. It may even be the case that the informal businesses in Nigeria is a good base for a circular economy, as they are able to produce long-lived, repairable and cyclable products which are relatively cheap and can be easily adapted to the needs of the people, also of poorer segments of the population. The discussion about "frugal innovations" addresses the interest of the poor to be supplied with such products at low price but with a high functional value (see on the theme: EJDR/European Journal of Development Research, November 2017). A circular economy approach is so important for countries like Nigeria as these countries need to save resources and funds by avoiding all forms of waste along the value chains. "Food Wastage" (summed up from "food loss" at and after harvest and "food waste" prior and during consumption) is an issue which reminds us that a circular economy approach is a complicated undertaking (Rockefeller Foundation, 2013); rearranging the agricultural and agribusiness value chains and changing the minds of the urban consumers about local food products and indigenous crops is a task involving so many stakeholders. Another trend is re-communalization in OECD countries, but also in Nigeria. Private sector involvement in waste management was popular some years ago, but now re-communalization is back; it may be argued that waste management is seen as a source of generating public revenues and higher wages for the waste management workers (see Böckers et al. 2017). The selective re-communalization (especially in large cities of Germany) may also mean less competition and less innovative activity, although this process is communicated as a step toward more innovations in the waste management business. In Nigeria, the mistrust against domestic and/or foreign waste management companies is widespread, and experiences in Lagos State are not that positive (HBSN/Heinrich Böll Stiftung Nigeria, 2018).

12.0 Conclusions

The study has twelve sections and these sections present a comparison of waste management policies and strategies in Nigeria (with a focus on Lagos) and Germany (with a focus on Bremen). Section 1.0 gives an Introduction. In section 2.0 an overview is presented on The

Waste Management Problems of Nigeria. Section 3.0 gives information on the Role of the Informal Private Sector in the Waste Management System of Nigeria. Section 4.0 is presenting the Role of the Formal Waste Management System in Nigeria. Section 5.0 gives a discussion on the Challenges to the Formal Waste Management System in Nigeria. Section 6.0 highlights the Relevance of Integrated Sustainable Waste Management (ISWM) Systems for Nigeria. In Section 7.0 an overview is given of Applying the Concept of an Integrated Sustainable Waste Management (ISWM) System in Nigeria. Section 8.0 gives details on Waste Generation and Waste Management in Germany: Structures, Trends, Strategies and Policies (With Implications for Waste Management Reforms in Nigeria). Section 9.0 presents a discussion on Waste Generation and Waste Management in the Country State and the Municipality of Bremen, Germany – Innovative Approaches. In Section 10.0 there is a presentation of The German Waste Management System in the European Union (EU): The Comparative Ranking of the German Waste Management System and Consequences for Reforms. Section 11.0 is bringing together the theme Towards an Integrated Sustainable Waste Management (ISWM) System: Practical Lessons for Nigeria from the German Waste Management System. Finally, Section 12.0 gives Conclusions.

This study investigates the progress of waste management policies in Nigeria and in Germany, with special emphasis on the conditions in the Lagos State of Nigeria and in the Country State of Bremen in Germany. Also, the move from waste management in the linear economic model to waste and resource management in the circular economic model is discussed. While waste management in the linear economic model focusses on a distinct hierarchy of objectives, the waste and resource management in the circular model incorporates the whole life cycle of (traditionally produced and newly designed) products among its objectives. Focus is on the country state of Lagos in Nigeria and on the country state of Bremen in Germany. Both country states have a great role as harbour and logistic towns, as industrial towns and services hubs, and as towns with a large scientific and technological infrastructure. The study compares the progress of waste management policies but also reflects on the different structures of waste management in the two country states, being the result of specific economic sectors and determining factors. Factors such as the importance of formal and informal private enterprises, the role of public

institutions and private actors in the waste management business, and the impact of public waste management policies, laws, plans and balance sheets play a role in the study; also, the importance of new equipment and of new communication technologies for the further development of the waste industry is considered.

The study is based on relevant literature which is available for the two countries/states and on meetings/interviews with experts on waste management in the two countries/states. A major result is that Germany (and Bremen) and Nigeria (and Lagos) can cooperate in a mutually beneficial way on waste management – in policymaking and planning, on developing and selecting equipment and new technologies, on services provision and training, but also on guiding the transformation process towards a circular economy. Nigeria can learn from the German and European way of implementing coherent policies, while Germany and Europe can learn from Nigeria's way to solve problems which arise at the local level. The study brought to attention that the waste industry in Germany (and in Bremen) is embedded in a complex web of directives, laws and regulations; this is a strict and coherent policy framework from the EU level downwards and to the EU level upwards. In Nigeria, there is no coherent waste governance system down from the federation, but at local and state levels there are some binding rules (of formal and/or informal origin) for actors/stakeholders. This quite different way of organizing waste management has consequences. For Nigeria, this situation means that local informal producers, local informal organizations, and local informal waste management actors play a great role. Important is it that informal actors in the waste management business are rediscovered as partners of public agencies, public firms and formal sector private firms. Informal sector firms can also be partners in the transformation from the waste management business in the linear economy model towards waste and resource management in the circular economy model. Informal enterprises are potential partners in a process of transformation towards a circular economy. Informal enterprises can ably prepare end-of-life products for re-use or they can make them the basis for recycling some parts and the recovery of some materials. Privatization versus re-communalization is another key issue of relevance for the waste industry as experiences in Lagos and in Bremen show. For Germany, the decision criterion should the ability to innovate for the transformation towards a circular economy; this aspect – innovativeness - should be the

basic criterion for privatization versus re-communalization. In Nigeria, a larger role of informal enterprises in the waste industry can contribute to the circular economy. Such firms can redesign the products and can remanufacture them for low-income social groups; waste can then be reduced or even prevented. Waste prevention is an issue for both countries/country states/municipalities. Bremen as a country state and Bremen as a municipality can give new ideas and plans to form a deep cooperation in a waste management partnership with Nigeria. Lagos can be the first address for such a cooperation, although the population size and the industry size of Lagos State are so much greater. It is interesting to see how important waste industry comparisons can be for the development of waste management strategies and for the transformation towards a circular economy.

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