

Dedication

To: Mother.

and Father.

and my, beloved
family.

TO:

the pure spirit of the teacher: Khaled Abdel-Aziz.

We will not forget and to live in us forever.

To those who shared my way

my friends.

Acknowledgments

Grapple with the characters and overcome feelings of words and their tongues to provide thanks and recognition to all who helped me to complete this research and humble thanks to the beginning and backwards to praise the owner of my entire Lord in glory

And then to set an example of science and perseverance, my mentor:

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Mr. Abas Abd alrasoul

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For providing me a place to study

To all of you many thanks and deep gratitude

Abstract

Energy is the prime mover in all development processes required by the States, and ways to provide and access is a concern for the whole world, whether it was in the major industrialized countries or developing countries.

The process of sustainable development requires proper planning of energy supply from various sources optimally, which take into account the efficiency of energy production and distribution and rational use in different aspects, taking into account the conservation of the environment in particular.

This includes research on six chapters. In the first chapter we review the role of nuclear energy in sustainable development in an attempt to clarify the importance played by it environmentally and economically, as we review the number of countries that fought in this area in an attempt to describe the extent of benefit which can be accessed from the various aspects of development. This raises the level of individuals, who work to build a new generation of development and keep working to solve the existing problems such as environmental pollution, which works to reduce the level to live in a healthy environment.

In chapter two, the essence of nuclear energy and ways to get it was explained, by with a focus on nuclear fission, and the best ways to get it and benefit from it. As the computer plays a key role in the conceptualization of the amount of gain and loss, operating and maintaining nuclear facilities so some of the basics used in modeling computing was addressed, with an explanation of the relations of the physical underpinnings, and some of the ways of computing used in reactors, such as calculating the cross sections of the interactions and determining the amount of energy obtained with an indication of the concepts of physics that underlie the computer

operations, Also types of nuclear reactors were given from several different areas, with an emphasis on research reactors and power reactors.

The thesis explains the various types of nuclear power reactors that are available. Those reactors widely vary in their technical design, performance, and safety features, fuel used and site conditions. In addition to that the financing requirements vary from one vendor to the other. Further, the licensing requirements of the vendor's country vary from one country to the other. These variations make it necessary to survey the market properly to find out the best nuclear power plant type that is suitable for Sudan. The work will be carried out by the NEPIO, the implementing organization, with the aid of appropriate consultants.

In Chapter Three a background about Sudan, is given with an explanation of the development efforts in the country, and a statement about its quest for its first nuclear power reactor to produce electricity.

Chapter four talks about the software in the plans of electricity generation followed by the National Electricity Corporation of Sudan.

Chapter five talks about the results and discussion.

In Chapter Six a conclusion and recommendations are given.

ملخص البحث

تعتبر الطاقة المحرك الاساسي في كل عمليات التنمية التي تحتاجها الدول، وطرق توفيرها والحصول عليها يعتبر هاجس للعالم ككل سواء إذا كان في الدول الصناعية الكبرى او الدول النامية.حيث إن عملية التنمية المستدامة تتطلب التخطيط السليم لإمداد الطاقة من مصادرها المختلفة بالصورة المثلي التي تراعي كفاءة إنتاج وتوزيع الطاقة وترشيد استخدامها في الأوجه المختلفة مع الأخذ في الإعتبار المحافظة علي البيئة بصفة خاصة. يشتمل هذا البحث علي سنة أبواب،في الباب الأول نستعرض دور الطاقة النووية في التنمية المستدامة في محاولة لتوضيح الأهمية التي تلعبها بيئياً و إقتصادياً ،كما نستعرض عدد الدول التي خاضت في هذا المجال في محاولة لبيان مدي الإستفادة التي من الممكن الوصول إليها من نواحي تنموية وثقافية ترفع من مستوي الأفراد مما يعمل علي بناء جيل جديد يواكب التطور ويعمل علي حل المشاكل القائمة مثل التلوث البيئي الذي يعمل علي تقليل نسب العيش بصورة صحية سليمة.

في الباب الثاني،توضيح لماهية الطاقة النووية وطرق الحصول عليها مع التركيز علي الإنشطار النووي وأفضل السبل للحصول عليه والإستفادة منه.وبما أن الحاسوب يلعب دوراً أساسياً في وضع تصور لمقدار الكسب والخسارة و التشغيل والمحافظة علي المنشآت النووية لذلك قمت بتوضيح بعض الأساسيات المتبعة في وضع النماذج الحوسبية مع توضيح للعلاقات الفيزيائية التي تقوم عليها،مع توضيح لبعض الطرق الحوسبية المتبعة في المفاعلات بحساب مقطع التفاعل وقياس كمية الطاقة المتحصل عليها مع بيان للمفاهيم الفيزيائية التي تقوم عليها العمليات الحاسوبية.كما يوضح انواع المفاعلات النووية من عدة نواحي مختلفة،مع التركيز علي المفاعلات البحثية ومفاعلات الطاقة.

ويوضح البحث ان مفاعلات الطاقة النووية المتوفرة تختلف اختلافاً كبيراً في تصميمها التقني- والادائي ومزايا السلامة، وانواع الوقود المستخدم وظروف الموقع. بالإضافة ألي إختلاف إحتياجات التمويل وشروط الترخيص حيث تختلف من بلد إلي آخر. هذه الإختلافات تجعل من الضروري دراسة السوق بتمعن لمعرفة أفضل محطة للطاقة النووية تصلح لتوليد الطاقة الكهربائية في السودان.

الباب الثالث يتحدث عن السودان وتاريخه التنموي مع توضيح للجهود السودانية وبيان لسعيها للحصول علي أول مفاعل نووي لإنتاج الكهرباء من حيث معدلات الانتاج للكهرباء حالياً ونموذج للمقدار المتوقع الحصول عليه من المفاعل.

الباب الرابع يتحدث عن البرامج الحوسبية في خطط التوليد الكهربائي التي تتبعها الهيئة القومية للكهرباء السودانية.

الباب الخامس يتحدث عن النتائج المستخلصة من البحث والمناقشة.

الباب السادس عبارة عن عرض وتحليل وتوصيات لما سبق ذكره.

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List of Abbreviations

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International Atomic Energy Agency	IAEA
International Energy Agency	IEA
Organization for Economic Cooperation and development	OECD
Nuclear energy System	NES
International Thermonuclear Experimental Reactor	IIER
Low - enriched Uranium	LEU
High - enriched Uranium	HEU
Nuclear Bower	NB
Pressurized Water Reactor	PWR
Veda-Vodyanoi Energeticheskyy Reactor	VVER
Boiling Water Reactor	BWR
Pressurized Heavy Water Reactor	PHWR
Canadian Deuterium Uranium	CANDU
Fast Neutron Reactor	FNR
Gas Cooled Reactors	GCRs
Advanced Gas Cooled Reactors	AGR
Light Water Graphite Reactor	LWGR

Fast Breeder Reactor FBR

Global Nuclear Energy Partnership GNEP

High Temperature gas cooled Reactors HTGRs

Steam Generating Heavy Water Moderated Reactor SGHWR

Heavy Water Moderated Boiling Light Water Cooled Reactor HWLWR

High Temperature Gas Cooled Graphite Moderated Reactor HTGR

Heavy Water Moderated Gas Cooled Reactor HWGCR

Liquid Metal Fast Breeder Reactor LMFBR

Pebble Bed Modular Reactor PBMR

Gas Turbine Modular Helium Reactor GT-MHR

Economic and Simplified Boiling Water Reactor ESBWR

Atomic Energy of Canada LTD AECL

Supercritical Water Cooled Reactor SWCR

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Molten Salt Breeder Reactor MSBR or MSR

Gas Cooled Fast Reactor GCFR

Lead Cooled Fast Reactor LCFR or LFR

Sodium Cooled Fast Reactor SCFR or SFR

Very High Temperature Gas Cooled Reactor	VHTR
Geological Research Association of Sudan	GRAS
Sudan Atomic Energy Commission	SAEC
Nuclear Power Programme	NPP
Nuclear Regulatory Body	NRB
Nuclear Energy System Assessment	NESA
Model for Analysis of Energy Demand	MAED
Model of Energy Supply Strategy Alternative and Their General Environmental Impacts	MESSAGE
Wien Automatic Systematic System Planning Package	WASP
Financial Analysis of Electric Sector Expansion plans	FINPLAN
Simplified Approach for Estimating Impacts of Electricity Generation	SIMPACTS
Indicators for sustainable Energy Development	ISED
International Project on Innovative Nuclear Reactors and Fuel cycle.	INPRO
Generation IV International Forum	GIF
Monte Carlo	MC
Burnable poison	BP
Burnable poison Compact	BPC

Gross Domestic Product GDP
Comprehensive Peace Agreement CPA
Multiplate Slab Geometry MTR
Oak Ridge National Laboratory ORNL
Millennium Development Goals MDGs
Atomic Vapor Laser Isotope Separation AVLIS or SILVA
Molecular Laser Isotope Separation MLIS or MOLIS
Electromagnetic Isotope Separation EMIS
Chemical Reactor by Isotope Selective Laser Activation CRISLA

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High level waste HLW
Low and intermediate level waste LILW
Very low level waste VLLW
Exempted waste EW
Low and Intermediate Level and short-lived waste LILW-SL
Radioactive waste management RWM
Design basis threat DBT