Palestine Polytechnic University

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Master Program of Renewable Energy and Sustainability

Assessment the Influence of Grid Connected Photovoltaic System on Medium Voltage Network in Tubas

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By

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Thesis submitted in partial fulfillment of requirements of the degree

Master of Science in Renewable Energy & Sustainability

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The undersigned hereby certify that they have read, examined and recommended to the Deanship of Graduate Studies and Scientific Research at Palestine Polytechnic University and the Faculty of Science at Al-Qdus University the approval of a thesis entitled:

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ABSTRACT

The increasing of electrical energy consumption and the immediate need of electricity in Palestine, lead us to think about enhancing and developing the electrical power system. Using of renewable energy systems, especially solar energy is one of the solutions to produce sustainable and environmentally friendly electrical energy systems in Palestine due to its location with a high potential of solar radiation. There are three PV plants installed in three different locations in Tubas medium voltage network which are Maslamani plant and two Czechia plants with 3 MW and 470 kW respectively, the total power output from the PV systems could reach 16% of the feeder load. These power plants were installed and connected to the grid with studding the side effects. Means that this integration affects the efficiency of the network and its continued service to the consumer, in addition to their impact in many respects related to power quality such as voltage profile, power factor and power loss based on standards. The Object of this study is to investigate the effect of connecting the up mentioned PV plants on the Tubas medium voltage networks as a case study and propose mitigation of these impact. A modelling of the case study was conducted using ETAP (Electrical Transient Analyzer Power) software where various solar PV penetration levels are added to the model and the power flow results are presented, which is the most comprehensive software used to design the integrated electrical systems. After propose the solution the first one add tap changer transformer and the second one add new feeder. The study results show that the voltage at the inter-connection point is enhanced through adding a tab changer transformer and the proposed new inter-connection point at a bus with suitable location. As a result of the simulation with adding Tap changer, it was found that the voltage fluctuation dropped to (3%) and the power losses to (14%). After adding the new feeder the voltage fluctuation reached up to (0.5%) and the losses to (5%). The results obtained were analyzed and presented in the study.

تقييم تأثير اتصال الأنظمة الكهروضوئية مع الشبكة على شبكة توزيع طوباس

زيادة استهلاك الطاقة الكهربائية والحاجة الفورية للكهرباء في فلسطين ، تقودنا إلى التفكير في تعزيز وتطوير نظام الطاقة الكهربائية. يعد استخدام أنظمة الطاقة المتجددة ، وخاصة الطاقة الشمسية ، أحد الطرق لإنتاج نظام طاقة كهربائية مستدامة وصديق للبيئة في فلسطين حيث تتمتع فلسطين بإمكانيات كبيرة من الإشعاع الشمسي. هناك ثلاثة محطات كهروضوئية تم تركيبها في ثلاثة مواقع مختلفة في شبكة طوباس ذات الجهد المتوسط وهي محطة مسلماني ومحطتان تشيكيتان ، 3 ميجاوات و 470 كيلوواط على التوالي،و يمكن أن يصل إجمالي انتاج الطاقة من أنظمة PV إلى 16٪ من الحمل الكلي. بنيت محطات الطاقة هذه دون دراسة الشبكة. يعني أن هذا التكامل يؤثر على كفاءة شبكة طوباس وخدمتها المستمرة للمستهلك في كثير من النواحي المتعلقة بجودة الطاقة مثل الجهد ومعامل تحسين القدرة و الطاقة الضائعة بناءً على معايير مختلفة. الهدف من هذه الدراسة هو دراسة تأثير توصيل المحطات الكهروضوئية المذكورة أعلاه على شبكات طوباس متوسطة الجهد كدراسة حالة. تم إجراء دراسة نموذجية لدراسة الحالة باستخدام برنامج ETAP حيث تمت إضافة مستويات اختراق الطاقة الشمسية الكهروضوئية إلى النموذج مع عرض نتائج تدفق الطاقة، وهو برنامج مناسب للغاية لتحليل تدفق الطاقة . تظهر نتائج الدراسة أن الجهد الكهربائي عند نقطة التوصيل الرئيسية قد تم تعزيزها من خلال إضافة محول تنظيم الجهد ونقطة ربط اضافية جديدة مقترحة في الموقع المناسب. بعد إضافة محول تنظيم الجهد وجد أن هذا يقلل من تذبذب التيار الكهربائي إلى (3٪) وفقدان الطاقة إلى (14٪). بعد إضافة وحدة التغذية الجديدة ، يصل تقلب الجهد (0.5٪) والخسائر إلى (5٪). تم تحليل النتائج وتقديمها في الدراسة.

DECLARATION

I declare that the Master Thesis entitled" **Assessment the Influence of Grid Connected Photovoltaic System on Distribution Network in Tubas**" is my own original work, and herby certify that unless stated, all work contained within this thesis is my own independent research and has not been submitted for the award of any other degree at any institution, except where due acknowledgement is made in the text.

Student Name: Yehya Nadi Hassouneh

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DEDICATION

This thesis is dedicated to:

The sake of Allah, my Creator and my Master,

My great teacher and messenger, Mohammed (May Allah bless

and grant him), who taught us the purpose of life,

My homeland Palestine, the warmest womb;

The great martyrs and prisoners, the symbol of sacrifice;

The Polytechnic University, my second magnificent home;

My great parents, who never stop giving of themselves in countless ways,

My dearest wife, who leads me through the valley of darkness with light of hope and support,

My beloved brothers and sisters; particularly my dearest brother, Imad, who stands by me when things look bleak,

My beloved kids: Nadi, and Eleen , whom I can't force myself to stop loving. To all my family, the symbol of love and giving,

My supervisor Prof . Abdel-Karim Daud

My friends who encourage and support me (Haitham ALqadi)

All the people in my life who touch my heart,

I dedicate this research.

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LIST OF ABBREVIATIONS

AC	Alternative Current
DC	Direct Current
DG	Distributed Generation
ECP	Electrical Connection Point
ECP	Energy Connection Point
ETAP	Electrical Transient Analysis Program
IEC	Israel Electrical Company
IEEE	Institute Electrical and Electronics Engineer
IEEE-SA	The Institute of Electrical and Electronics Engineers Standards Association
KWh	Kilo Watt Hour
LTC	Load Tap Changer
MPPT	Maximum Power Point
MV	Medium Voltage
PCC	Point of Common Coupling
PF	Power Factor
PSH	Peak Sun Hour
PV	Photovoltaic
PV-syst	Software PV-syst
SLD	Single Line Diagram
SPV	Solar Photovoltaic
TEDCO	Tubas Electrical Distribution Company
THD	Total Harmonic Distortion