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# COMPATIBILITY OF RENEWABLE ENERGIES WITH THE STANDARDS OF ENERGY MANAGEMENT SYSTEM AND ENVIRONMENTAL DESIGN OF GREEN BUILDINGS

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## ABSTRACT

The world today faces challenges in the form of population growth, resource consumption, environmental degradation, climate change and energy crises. Unless some immediate remedial measures are taken, things are expected to get worse. There is a need to protect the environment by preserving it through the production of clean energy, represented by new and renewable energies, to deal with energy problems and environmental degradation. The close link between development and environment has led to a phenomenon called sustainability, which requires attention to environmental protection, taking into account that renewable energies are one of the most important means of protecting the environment. Therefore, many countries are now developing renewable energy sources and set a goal to achieve the efficiency of the built environment and face future environmental challenges and construction. The paper presents the relationship between the use of renewable energies and the adoption of building design as sustainable buildings. The aims of the study are that there is a direct positive relationship between the use of properties acquired by renewable energies as a complementary method in the field of energy efficiency in buildings and the adoption of sustainable building design, according to one of the most important global sustainable building assessment systems, the system of energy leadership and environmental design (LEED). Determining the number of points that the use of renewable energies can contribute and is appropriate to the total number of points for all determinants and strategies of sustainability in global building sustainability assessment systems.

**KEY WORDS: Renewable Energy, Renewable Energy Sources, Sustainability Issues, LEED (Leadership And Environmental Design), Envi ronmental Sustainability Engineering**.

## توافق الطاقات المتجددة مع معايير نظام إدارة الطاقة والتصميم البيئي للمباني الخضراء

**نورهان محمد صبحي شرف الدين* و محمد صلاح الدين السيد و وائل صديق مصطفى و هبة محمد عبده**

كلية الهندسة، قسم الهندسة المعمارية، جامعة المنصورة، المنصورة ، مصر

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**الملخص**

يواجه العالم اليوم تحديات في شكل النمو السكاني، واستهلاك الموارد والتدهور البيئي وتغير المناخ وأزمات الطاقة. ما لم يتم اتخاذ بعض التدابير العلاجية الفورية، من المتوقع أن تزداد الأمور سوءًا. هناك حاجة لحماية البيئة وذلك بالحفاظ عليها من خلال إنتاج الطاقة النظيفة المتمثلة في الطاقات الجديدة والمتجددة، للتعامل مع مشاكل الطاقة والتدهور البيئي. أدي الارتباط الوثيق بين التنمية والبيئة إلى ظهور ما يسمى الا ستدامة، الأمر الذي يستلزم الاهتمام بحماية البيئة، مع اخذ في

الاعتبار ان الطاقات المتجددة أحد أهم وسائل حماية البيئة. لذلك نجد الكثير من الدول ألان تقوم بتطوير مصادر الطاقات المتجددة وتضعه هدفا تسعى لتحقيقه في رفع كفاءة البيئة المشيدة ومواجهة التحديات البيئية المستقبلية ومجال البناء.

تطرح الورقة البحثية إلى توضيح العلاقة بين استخدام الطاقات المتجددة وبين اعتماد تصميم المباني كمباني مستدامة. وتتلخص أهداف الدراسة بان هناك علاقة إيجابية مباشرة بين استخدام الخصائص التي اكتسبتها الطاقات المتجددة كأسلوب مكمل في مـ جال كفاءة الطاقة في المباني واعتماد تصميم المباني المستدامة وفقا لأحد أهم نظم تقييم البناء المستدام العالمية وهو نظام الريادة في الطاقة والتصميم البيئي. وبيان عدد النقاط التي يمكن أن تسهم بها استخدام الطاقات المتجددة وبين ملائمة مع عدد النقاط الكلي لجميع محددات واستراتيجيات الاستدامة في نظم تقييم استدامة المباني العالمية.

**الكلمات المفتاحية: الطاقة المتجددة، ومصادر الطاقة المتجددة، وقضايا الاستدامة، LEED (القيادة والتصميم البيئي) وهندسة الاستدامة البيئية.**

## INTRODUCTION

The study search for examining the potential and trends in sustainable development with renewable energy sources, there is a positive connection between the usage of properties learned by renewable energies an additional technique in the field of construction and strategy of the buildings sustainability environmentally friendly resources with the ratings developed in the light of sustainable international construction assessment systems. (Cohen, 2007)

Stimulated by recent technological advances and growing concern over the sustainability and environmental impression of conventional fuel usage, the scene of creating clean, sustainable power in substantial measures from renewable energy sources produces interest around the world. This paper provides a complete overview of the major types of renewable energy--including solar, thermal, photovoltaics, bioenergy, hydro, tidal, wind, wave, and geothermal. It studies the environmental effect and predictions of different energy sources. (Boyle, 2004)

## RENEWABLE ENERGY AND SUSTAINABLE DEVELOPMENT

Renewable energy directly related to sustainable development through its effect on human development and economic production. The convenience of renewable energy sources and energy security, chances for social and economic development, and admission to energy, and the justification of climate transformation and the decrease of environmental and health effects. (Asumadu-Sarkodie, 2016)

## RENEWABLE ENERGY RESOURCES AND TECHNOLOGY

Renewable sources of energy knowledge and renewable energy sources are bases of energy from ordinary and continuous flow of energy happens in the direct environment. They include: direct vital energy, solar energy and geothermal energy and hydropower, wind energy, biomass energy, waste material energy, ocean and waves energy. (Bull, 2001)

*Solar energy:*

The word "direct" solar energy mentions the energy base for those renewable energy source technologies that draw on the Sun's energy directly, shown in Figure (1). Some renewable knowledges, such as wind and ocean thermal, use solar energy next to it has been fascinated on the earth and transformed to the other forms. Solar energy skills is obtained from solar irradiance to produce electricity using photovoltaic (PV) (Asumadu-Sarkodie, 2016) and concentrating solar power (CSP), to produce thermal energy, to meet direct lighting needs and, potentially`, to

**Figure (1) Active and passive solar energy ((NREL), 2018)**

produce fuels that could be used for transportation and other resolutions (Edenhofer, 2011). Solar energy can be applied in form of active solar energy and passive solar energy. According to the World Energy Council (Council, 2013) ,"the total energy from solar

radiation which radiates on the earth was more than 7,500 times the World's total annual principal energy consumption of 450 EJ" (Urban, 2011).

*Wind Energy*

Winds generates several layers of the atmosphere absorb different quantities of heat and develop differently. For countries, wind energy used to sail ships and pump water (Ahmed, 2015). To creates the maximum electricity possible, wind turbines want to be placed in areas wherever the wind blows at a endless speed. Huge groups of wind turbines, called wind farms or wind plants, are linked to electric utility power line and offer electricity to many people which shown in Figure (2) (Zin, 2013). An advantage of wind turbines over some other forms of renewable energy is that they create electricity whenever the wind shocks (at night and also during the day). But, even in the windiest of places, the wind does not upset all the time. Consequently, small wind systems requirement back up batteries. Hillsides, mountains and open places are the top sites to set up wind turbines. (Shepherd, 2011).

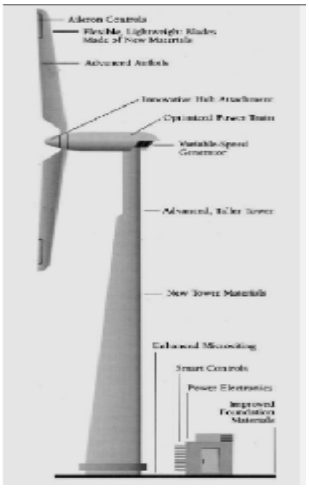

**Figure (2) Modern wind turbine for utility scale power generation. (Ahmed, 2015)**

*Ocean energy (tide and wave)*

Surface waves are generated when wind moves over water (Ocean). The more rapidly the wind speed is, the longer the wind is sustained, the bigger distance the wind moves, the larger the wave height, and the larger the wave energy formed (Jacobson, 2011). The ocean stores abundant energy to see the total worldwide request for power several times concluded in the method of waves, tide, flows and heat. The year 2008 saying the start of the first generation of commercial Ocean energy strategies. There are currently four ways of finding energy from sea zones, specifically from Wind, Tides, Waves and Thermal changes between deep and shallow Sea water as shown in Figure (3) (Esteban, 2012).

**Figure 3 Oceans & Waves Energy (Jeans, et al., 2013)**

*Biomass Energy*

Bio-energy is the energy from bio-mass or organic material such as wood. Biomass was used for centuries, right from the time persons energy began burning wood to cook or to save warm. although wood, in various forms, still the main biomass resources for bio-energy, there are now additional sources such as farming be located in, plants, and waste materials (Hoogwijk, 2005).

The usage of bioenergy produces as much carbon dioxide such as fossil fuels, each new plant that raises removes carbon dioxide eliminated from the atmosphere, thus continuing an ecological tability, with net productions being near to zero of new plants are grownup each time an old one is burnt (Ayoub, 2012). To increase agricultural proceeds while at the same time maintain environmental stabilities, fast increasing trees and grasses can be planted (Demirbas, 2009). These plants are named Bio-Energy feed tocks'. It can be classified into three main types (Wood fuels- Agrofuels- Fuels resulting from urban waste).

*Waste Materials Energy*

Community solid waste has the probable to be a great source. It moderates the problem if waste clearance specially in countries There is not abundant landfill space to landfill the waste. This community solid waste can be seared in great power plants to produce electric power (Johari, 2012). Community waste-to energy plants presently produce about 2500 mega-watts of electricity. There is also additional ways to trap the energy in garbage. When food scraping and wastes decline, methane, a green-house gas with 22 time the global warming probable of carbon dioxide is formed. It can be collected, cleaned and seared to form steam in a boiler or energy producers coproduce electricity (Johari, 2012).

*Hydropower energy*

Power from the water in the rivers and streams is identified as hydropower, or hydroelectric power is between the most usually used forms of renewable energy in the world. It accounts for about 20% of worldwide electricity stock. The greatest mutual method in which hydro-electric power plant works can be summarized in the following Figure (4). (Edenhofer, 2011)

Hydropower is an important energy source attached from water moving from top to low elevation levels, mainly to turn turbines and produce electricity. Hydropower projects consist of Dam project with reservoirs, run-of-river and in-stream projects and cover a range in project scale. (Finn R, 2015)

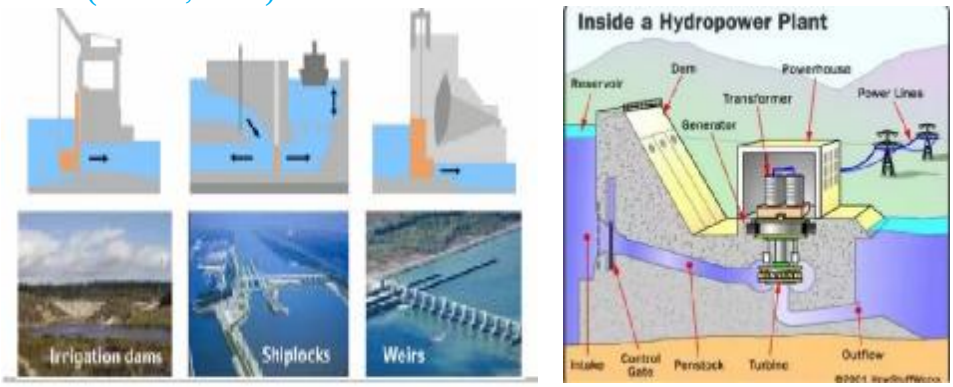


**Figure (4) Principal of Hydroelectric Power Generation, and typical applications of dam. (Edenhofer, 2011)**

## Geothermal energy

Geothermal energy increased obviously from the earth's central as heat energy source. The source of the heat is associated with the inner structure of the earth and the physical procedures taking place there. While warmth is existing in the earth's top in huge extents, not to remark the deepest parts, it is irregularly scattered, rarely concerted, and often at depths also great to be broken mechanically.

Geothermal rise averages about 30 °C/km. There are parts of the earth's interior which are available by penetrating.(Barbier, 2002).

Heat is extracted from geothermal reservoirs using wells and other resources. Reservoirs that are obviously sufficiently hot and permeable are named hydrothermal reservoirs, while tanks that are acceptably hot but are upgraded with hydraulic stimulation are named enhanced geothermal systems (ESG). Once strained to the surface, fluids of several temperatures used to produce electricity and other determinations that involve the usage of heat energy (Edenhofer, 2011).

## Renewable energy and sustainable development

Renewable energy has straight relationship with sustainable progress through its effect on human growth and economic production (Asumadu-Sarkodie, 2016). Renewable energy bases provide occasions in energy security, social and economic development, climate change justification and the reduction of environmental and health effects (Asumadu-Sarkodie, 2016).

Compatibility of Renewable Energies with the standards of energy management system and environmental design of green buildings:

System assessment points are calculated by obtaining one or more green squares according to LEED points in any cell resulting from the intersection of the Sustainability Assessment Criterion with the properties of the renewable energies. This means that this property has an impact that will get the points necessary to meet sustainability criteria. Shaded squares in a row will not give greater points.

| LEED V.3-2009 NC | Renewable energy with sustainable future architecture | | | | | | | Total points added |
|---|---|---|---|---|---|---|---|---|
| 1-Sustainable Sites | Solar Energy | Wind Energy | Ocean & Waves Energy | Biomass Energy | waste material Energy | Hydropower Energy | Geothermal Energy | 17/26 |
| | | | | | | | | 16/26 |
| Protection from pollution resulting from construction activities | Aimed at reducing the pollution resulting from the various construction activities and methods of controlling the rates of soil erosion and sedimentation in the waterways and the generation of harmful dust and dust | | | | | | | Basic |
| | | | | | | | | |
| Site Selection | Avoid developing unsuitable sites for the nature of the project and reduce the impact of the passive building site on the surrounding environment. | | | | | | | 1/1 |
| | | | | | | | | |
| Development Density and Community Connectivity | Aims to link urban development plans with available infrastructure | | | | | | | 0/5 |
| | | | | | | | | |
| Brownfield Redevelopment | Aims to rehabilitate or develop areas of waste, contaminants and abandoned areas, which contain a high percentage of pollutants | | | | | | | 1/1 |
| | | | | | | | | |
| Alternative transportation (Public Transportation Access - Bicycle Storage and Changing Rooms - Low-Emitting and Fuel-Efficient Vehicles - Parking Capacity) | Aims to reduce the impact of pollution resulting from the use of cars and reduce all negative environmental impacts on the environment resulting from the operation of their service projects | | | | | | | 12/12 |
| | | | | | | | | |
| Site development (Protect or Restore Habitat - Maximize Open Space) | Aims to protect natural sites from the negative effects of building and the operation and maintenance of damaged sites and increase the proportion of open spaces to increase the scope of biodiversity | | | | | | | 0/2 |
| | | | | | | | | |
| Stormwater design (Quantity and Quality Control) | The aim is to reduce the damage to natural water hydrology by reducing non-leaking surfaces and increasing the leakage through the surface of the water at the site and reduce the pollution by increasing the rate of runoff and pollution reduction. | | | | | | | 0/2 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Heat Island Effect (Nonroof – Roof)** | **Aimed at reducing the phenomenon of thermal islands developed to reduce their impact on the local climate and human settlements and wildlife** | | | | | | | **2/2** |
| **Reduce light pollution** | **Designed to reduce lighting consumption in building and location, reduce glow and improve night vision** | | | | | | | **1/1** |
| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
| **2- Water Efficiency** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **0/10** **0/10** |
| **Water efficient landscaping** | **Aimed at reducing the use of drinking water and groundwater and surface water sources near the project site in the irrigation of gardens by reducing water consumption by 50%** | | | | | | | **0/4** |
| **Innovative technologies for wastewater use** | **Aimed at reducing the generation of waste water and reducing the demand for drinking water, and not to damage the stocks of local aquifers** | | | | | | | **0/2** |
| **Reduce water use** | **Aims to raise the efficiency of water used in buildings to reduce the burden on water supply systems and sewage systems** | | | | | | | **0/4** |
| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
| **3- Energy & Atmosphere** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **35/35** **35/35** |
| **Fundamental Commissioning of Building Energy Systems** | **Appropriate to the system is that the power systems in the building have been equipped and calibrated.** | | | | | | | **Basic** |
| **Minimum Energy Performance** | **It aims to adopt the specifications adopted by the electrical authorities and the efficiency of the design of the building cover, air conditioning systems, lighting and other systems in order to raise the level of energy performance** | | | | | | | **Basic** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Fundamental Refrigerant Management** | **Aimed at reducing depletion of the ozone layer** | | | | | | | **Basic** |
| **Optimize Energy Performance** | **Aims to raise the performance of energy higher than the basic limit to reduce the adverse impact on the environment and the economy from excessive use of energy** | | | | | | | **19/19** |
| **Renewable energy on site** | **Aims to promote and recognize the increase in levels of renewable energy use on-site for self-sufficient clean energy, to reduce the adverse impact on the environment and the economy from the use of fossil fuels** | | | | | | | **7/7** |
| **Enhanced Commissioning** | **Aims to initiate the recruitment process during the design and implementation phase of some tasks after the completion of the verification phase** | | | | | | | **2/2** |
| **Enhanced Refrigerant Management** | **Aiming to reduce depletion of the ozone layer during all operations above the baseline limit** | | | | | | | **2/2** |
| **Measurement and Verification** | **The aim is to provide the building with energy consumption meters permanently** | | | | | | | **3/3** |
| **Green Power** | **Aims to promote the development and use of renewable energy technologies on the basis of zero pollution** | | | | | | | **2/2** |
| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
| **4- Indoor Environment Quality** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **13/15**<br>**8/15** |
| **Monitor ventilation rate** | **Aims to provide the building with a ventilation control system to ensure the health and safety of the population in a sustainable manner** | | | | | | | **1/1** |
| **Monitor ventilation rate** | **Aims to provide external ventilation to improve indoor air quality for the comfort, health and productivity of the population** | | | | | | | **1/1** |
| **Construction Indoor Air Quality Management Plan (During Construction - Before Occupancy)** | **Aimed at reducing the problems of indoor air quality resulting from the construction or restoration process for the convenience and health of workers and residents** | | | | | | | **1/1** |
| **Use low emission materials** | **The aim is to reduce the amount of indoor air pollutants such as bad smell and harmful to the comfort and health of workers, users and occupants of the building.** | | | | | | | **4/4** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Indoor Chemical and Pollutant Source Control** | **Aimed at reducing the exposure of the building population to hazardous substances and chemical pollutants** | | | | | | | **0/1** |
| **Use of controllable systems (Lighting - Thermal Comfort)** | **Aims to provide high level of control of lighting and air conditioning systems by individual population or groups by place to raise the productivity, comfort and health of the residents of the building** | | | | | | | **2/2** |
| **Achieve thermal comfort (Design - Verification)** | **Designed to provide buildings with convenient thermal systems to improve the productivity and health of the occupants of the building through the design of the building envelope and systems capable of giving optimal performance to the factors of comfort under environmental conditions and the expected use of the building.** | | | | | | | **2/2** |
| **Natural lighting and vision** | **The aim is to provide residents of the building a link between the interior spaces with the exterior by bringing the lighting nature and landscapes of the traditionally inhabited spaces of the building** | | | | | | | **2/2** |
| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
| **5- Innovation &Design Process** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **6/6** |
| | | | | | | | | **6/6** |
| **Innovation in Design** | **Designed to provide design and project teams with the opportunity to score points for outstanding performance beyond the system requirements for new green buildings** | | | | | | | **5/5** |
| **LEED Accredited Professional** | **Aims to support and encourage the integration of design required by the new green building appraisal system** | | | | | | | **1/1** |
| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
| **6- Materials and Resources** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **11/14** |
| | | | | | | | | **4/14** |
| **Storage and collection of recyclable materials** | **Designed to facilitate the reduction of waste by the residents of the building and collected and dumped in the landfill** | | | | | | | **Basic** |
| **Reuse the building** | **Aimed at prolonging the building's lifecycle, conserving resources, conserving cultural resources, minimizing waste and reducing the negative environmental impact of new buildings in the manufacture, transport and recycling of materials** | | | | | | | **4/4** |

| | | |
|---|---|---|
| **Construction waste management** | **Aimed at reorienting recyclable sources into manufacturing and reusable materials to appropriate locations** | **2/2** |
| **Reuse materials and resources** | **Aims to reuse materials and building products to reduce the demand for new materials and reduce waste thereby reducing the impact of production and manufacture of new materials** | **2/2** |
| **Utilization of recyclable contents** | **Aims to increase demand for products containing recycled components as they reduce the impact of production and processing of new materials** | **2/2** |
| **Use of local materials** | **Aimed at increasing the demand for construction materials extracted and manufactured in the local environment to support the use of indigenous sources and to minimize the environmental impacts of transport** | **0/2** |
| **Use of rapidly renewable materials** | **Aimed at reducing the use and depletion of raw materials and renewable long materials and replacing them with materials that can be rapidly renewed** | **0/1** |
| **Use of certified timber** | **Aimed at supporting the use of licensed timber to promote environmentally responsible forest management** | **1/1** |

| **LEED V.3-2009 NC** | **Renewable energy with sustainable future architecture** | | | | | | | **Total points added** |
|---|---|---|---|---|---|---|---|---|
| **7- Regional priority** | **Solar Energy** | **Wind Energy** | **Ocean & Waves Energy** | **Biomass Energy** | **waste material Energy** | **Hydropower Energy** | **Geothermal Energy** | **4/4** |
| **Regional priorities** | **The aim is to increase the relative weight of the standards related to the regional environmental significance, and to encourage the application of those standards that meet the needs of the areas in which they exist and are effectively adapted to their nature.** | | | | | | | 4/4 |

- **Total points gained by using Renewable energies = 88/110 points**
- **Total points gained by using Solar Energy = 73/110 points = Golden classification**
- **Total points gained by using Wind Energy = 66/110 points = Golden classification**
- **Total points gained by using Geothermal Energy = 43/110 = certified classification**

## CONCLUSION

The number of LEED Sustainability Score points gained from the integration of the renewable energies with the building is up to **88 points** from the total points of the system. The number of points earned is sufficient to qualify the building to reach the classification of the advanced system, which is the **platinum classification** of one rank less than the highest category of assessment is the platinum rating, a distinctive indicator of the strength of the level of environmental performance of the building.

in additional, it was found that the number of points earned from applying **(Solar Energy)** is up to **73 points** to reach **golden classification**, **(Wind Energy)** is up to **66 points** to reach **golden classification** and **(Geothermal Energy)** is up to **43 points** to reach **certified classification.**

Renewable energies contribute to the provision of innovative future solutions the ability to change the physical and mechanical properties of the traditional building design and have significant environmental and economic effects in the medium and long term of the building's and take into account the achievement of elements of speed.

From the previous analysis and conclusions, the following can be found: There is a positive relationship between the use of properties acquired by the renewable energies as a complementary technique in the field of energy efficiency in buildings and the adoption of sustainable buildings design.

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