

ICT, Financial Globalization and Ecological Sustainability in Oman: Novel Evidence Based on Load Capacity Factor

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ABSTRACT

The current study aims to explore the interconnectedness between financial globalization, information and communication technology (ICT), non-renewable energy consumption, and ecological sustainability in Oman over the quarterly data from 1998Q1 to 2022Q4. While there have been numerous studies that have tested the ecological sustainability determinants in Oman using indicators like carbon emissions (CO₂) and ecological footprint, a comprehensive evaluation of the Load Capacity Factor (LCF) in the context of Oman remains notably absent. LCF captures both the supply and demand aspects of nature, offering a better analysis of ecological sustainability. This work fills the gap by examining the impact of financial globalization, ICT, and non-renewable energy on ecological sustainability in the case of Oman. The findings of this work show that ICT has been observed to have a positive effect on environmental sustainability by increasing LCF. Furthermore, we found that financial globalization has a positive impact on LCF, while nonrenewable energy use has been found to have adverse effects on LCF. The findings suggest that policymakers should encourage the use of renewable energy sources and accelerate the transition to digital technologies.

Keywords: ICT, LCF, Oman, Energy, Sustainability.

Mathematics Subject Classification: 28-XX

JEL Classification Number: D, E, O, R

1. INTRODUCTION

Currently, transition to a green economy and ecological sustainability have become the most critical environmental and economic issues (Awosusi et al., 2022). However, promoting the environment requires different strategies, particularly in information and communication technologies (ICT). Nowadays, ICT adoption is important to a nation's economic development in the transition to a knowledge-based economy (Aydin et al., 2025). In this context, ICT adoption can create a wide array of opportunities, facilitate human communication, and reduce operational costs (Zhou et al., 2019). In terms of the environment, many discussions center around ICT effects. In this way, ICT can play a

positive role in reinforcing ecological neutrality in different ways. For example, ICT adoption offers frameworks and tools that can improve corporate productivity, reinforce green practices across different sectors, and potentially reinforce energy efficiency and reduce green energy cost (Anser et al., 2021; Jin & Yu, 2022; Moyer & Hughes, 2012). In the empirical literature, several papers assessed the impact of ICT on ecological quality: For instance, Aydin et al. (2025) in Denmark, Wen et al. (2025) in BRISC, Chatti and Majeed (2022) in 94 developing and developed economies, and Ulussever et al. (2024) in the case of GCC economies. However, the mechanisms through which ICT contributes to ecological neutrality based on the novel indicator of LCF, particularly in the context of Oman, are still ignored. This research aims to study the determinants of ecological sustainability using the novel indicator of load capacity factor in Oman.

Moreover, the dynamics of financial globalization (FG) can affect ecological sustainability. FG has led the world economy to reinforce interdependencies among the economies and generate societal benefits in developed and developing economies over the last decades. Hence, the FG can promote economic development by increasing investment and capital flows (Sadiq et al., 2022). Every human is affected by FG in different forms, whether through changes in energy use, technology adoption, investment, industrial, or environmental alterations (Zaidi et al., 2019). Among these changes, FG and ecological sustainability are the most challenging. Whether leading oil-exporting countries such as Oman can promote economic development with the help of FG without damaging the ecological quality is a critical question.

There are several reasons why the country of Oman is considered for the study. Oman has undergone a sharp economic development, leading to a significant rise in fossil fuels. Despite this, per capita carbon emissions declined from around 18.55 tons in 2010 to 15.54 tons in 2023. The country is still ranked among the highest CO₂ emitters from the utilization of fossil fuel sources (oil, gas, and coal consumption). Thus, the primary strategy in Oman is to support ecological quality. In this way, the Omani government launched the 2040 strategy, which aims to increase the use of green energy and mitigate environmental pollution to meet the target of 1.5 °C global warming (Kilinc-Ata, 2025). Nevertheless, the economic growth process in Oman has increased significantly over the last few years. In this regard, the GDP growth in Oman rose from 12 billion U.S. dollars in 1990 to 106 billion dollars in 2024. Besides, the ICT sector has experienced significant improvement over the last decade. Oman's ICT market size is estimated at USD 5.96 billion in 2025 and is estimated to reach USD 9.11 billion by 2030. Thus, the prevailing paper aims to explore the effect of ICT, renewable energy, and FG on LCF in the context of Oman over the period 1998Q1–2022Q4.

The current work contributes to the literature in different ways: Several empirical works confirmed that financial globalization considerably impacts ecological sustainability (Aydin et al., 2025; Chatti & Majeed, 2022; Le & Ozturk, 2020; Sadiq et al., 2020; Ulucak et al., 2020; Wen et al., 2022). Few empirical works assessed the interconnection among ICT, FG, and LCF (e.g., Dogan & Pata, 2022; Xu et al., 2022). The influence of ICT and FG on ecological neutrality in Oman is neglected. In this context, the prime novelty of this study is to investigate the effects of ICT and FG on LCF in Oman, which is the region's leading ecological polluter. The LCF indicator is captured and measured by dividing biocapacity by ecological footprint (EF), where biocapacity represents the supply side of environmental

sustainability via the productivity of environmental assets in the country. At the same time, EF reflects the amount of land needed to sustain the people use of natural resources (Hammami et al., 2025). Second, the study used an advanced method of Augmented Autoregressive Distributed-Lag (AARDL) as introduced by Sam et al. (2019). Unlike classical approaches, this method assesses the inconclusive cases, which inturn overcomes the instability issue of classical approaches. Further, this approach considers the $F_{\text{statistic}}$ for the overall test and the $t_{\text{statistic}}$ and $F_{\text{statistic}}$ a lagged dependent and independent variables, respectively, offering better findings than other approaches of cointegration. Third, this work aims to offer some essential implications to Oman's government to promote the environmental neutrality quality in the country using technological and financial tools. The structure of this study is designed as follows: Section 2 shows the literature review. Sections 3 and 4 represent the study methodology and empirical findings. Section 5 describes the findings discussion. Finally, Section 6 represents the main conclusion of this work.

2. LITERATURE REVIEW

2.1 ICT and load capacity factors

Regarding the effect of ICT on ecological quality, many of the conclusions given in empirical literature focus on the adverse or positive impact of its development on ecological sustainability. The positive effect of ICT on ecological neutrality could be attributed to several reasons. For example, more ICT can facilitate the green technologies adoption to promote green growth. In this way, ICT can play a positive role in encouraging environmentally friendly production methods and increasing energy efficiency. Subsequently, it leads to promote ecological stability (Wen et al., 2025). Further, ICT adoption can help mitigate fossil fuel use in several sectors, such as transportation and smart buildings, leading to a reduction in the level of ecological pollution emissions. In contrast, Aydin et al. (2025) found that ICT may negatively affect environmental quality as it increases non-renewable energy consumption. According to the authors, data centers generate large amounts of heat, which in turn needs cooling systems that consume high levels of fossil fuel, leading to high CO₂ emissions. In addition, the lack of green ICT policies adversely affects ecological quality. Chatti and Majeed (2022) employed the Generalized Method of Moments method (GMM) for 94 developing and developed economies and indicated that ICT adoption within urban areas mitigates the level of CO₂ emissions from 1998 to 2016. Dogan and Pata (2022) tested this linkage in the context of the G7, the authors suggest positive connection between ICT and LCF, suggesting the positive role of ICT in promoting ecological sustainability. In the context of GCC countries, Islam et al. (2023) used generalized least square (GLS) techniques and found that ICT has an adverse effect on CO₂ over the period from 1995 to 2019. Recently, Wen et al. (2025) used Feasible Generalized Least Squares (FGLS) in the context of BRICS countries and indicated that digital technology mitigates the level of CO₂ emissions, suggesting a positive role of digitalization in supporting environmental neutrality. Yi et al. (2025) suggested a positive connection among this linkage in the case of China from 2008 to 2018. Ulussever et al. (2024) evaluated this linkage in the case of GCC, using an augmented mean group approach panel approach, and found a positive role of ICT on the ecological sustainability over the period from 2000 to 2019. Recently, some studies used the novel indicator of LCF to capture ecological sustainability. Aydin et al. (2025) tested

the impact of ICT on the LCF in Denmark from 1996 to 2021. Using ARDL approach, the author underscores the significant role of ICT in enhancing the LCF.

2.2 Financial globalization and load capacity factor

The discussion about the effects of financial globalization (FG) on ecological sustainability issues is a recent subject matter. Increasing FG in both developed and developing economies increased trade integration among the countries, increased technology transfers, and financial activities (Xu et al., 2022). Subsequently, it has considerable ecological implications at the local and global levels (Zhang et al., 2023). In this context, Nadiri et al. (2024) suggest that FG promotes ecological sustainability by easing laws and intensifying among the economies and encouraging green foreign direct investment (FDI) and liabilities.

Conversely, the hypothesis of Pollution Haven claims that more FDI from developed economies to other emerging economies may adversely affect ecological sustainability (Nadeem et al., 2020). In empirical literature, several works assessed the impact of FG on ecological neutrality. Kediri et al. (2024) used Granger-causality and found a one-way causal effect running from FG to carbon emissions over the period from 1970 to 2020. Ulucak et al. (2020) used ARDL and Dynamic Ordinary Least Squares methods for emerging economies and found that FG promotes environmental quality over the period from 1974 to 2016 by mitigating the ecological footprint. Chen et al. (2023) used MMQR and found that FG supports the environmental neutrality of G7 countries from 1990 to 2020. Nadiri et al. (2024) tested this interconnection in the context of EU member countries. Using CS-ARDL, the authors highlighted the positive role of FG in mitigating the level of CO₂ emissions from 1994 to 2019. Conversely, Le and Ozturk (2020) used the AMG test and suggest that FG has a positive influence on ecological pollution by increasing the level of CO₂ emissions from 1990 to 2014. Sadiq et al. (2020) explored the interaction among environmental footprints and FG using the CS-ARDL technique for BRICS economies. The study indicates that FG accelerates the ecological deterioration over the period from 1990 to 2019. Recently, some works assessed the impact of FG on LCF. For example, Adebayo et al. (2022) examined the link among FG and LCF in the case of G7 region from 1990 to 2018. Using a quantile-based approach, the author found that the positive effect of FG on LCF.

Xu et al. (2022) utilized the ARDL approach and found a positive role of FG on LCF in Brazil over the period from 1970 to 2017. A recent study conducted by Ali et al. (2025) tested this link in leading nuclear energy consumer economies. The authors highlight the positive role of FG in supporting the environment by increasing the LCF from 1995 to 2020. Ximei et al. (2025) employed advanced panel data and found that economic globalization in the context of Asia-Pacific Economic Cooperation (APEC) economies promotes LCF.

2.3 Literature Gap

The lack of agreement in the outcomes of the empirical studies on the linkage among ICT, FG, and LCF could be attributed to the use of different econometric methods, different economies and regions, and different periods. Varying outcomes suggest that these topics require more investigation, particularly in the context of Oman. Unlike the present studies, our work aims to examine the effect of FG and ICT on ecological sustainability using the novel indicator of LCF. To the best of our knowledge, most of the

studies ignored this role in the context of Oman. The findings of this work serve to resolve the ongoing discussion regarding the linkage among ICT, FG, and LCF in one of the leading oil-exporting countries. Further, this work aims to offer fresh insight into this linkage using the advanced augmented ARDL approach. This approach varies from the classical ARDL approach in different ways. Unlike traditional methods, this AARDL method assesses the inconclusive cases, which in turn overcomes the instability issue of traditional methods.

3. METHODOLOGY AND DATA SOURCES

The ecological sustainability in the context of Oman is primarily discussed in the current empirical literature; however, no empirical study has assessed the ecological sustainability using the novel LCF. In this regard, the present work uses the case of Oman to evaluate the determinants of LCF. The theoretical connection among the tested variables is expressed as follows:

$$\ln LCF_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 NREC_{it} + \beta_3 ICT_{it} + \beta_4 \ln FG_{it} + \varepsilon_t \quad (1)$$

In Equation 1, $\ln LCF_{it}$ means the load capacity factor, $\ln NREC_{it}$ means nonrenewable energy consumption. $\ln ICT_{it}$ means information and communication technology. $\ln FG$ is financial globalization. All the studied variables of this work were in a natural log. The data explored in this study is the quarterly data covering the period from 1998Q1 to 2022Q4. The measurement of the selected variables is presented in Table 1.

Table A1. Description of the selected Variable and sources

Variable	Indicator	Measurement	Source
LCF	Load Capacity factor	This index obtained from division biocapacity (per-capita) and Ecological footprint (Global hectares per capita.	Global-Footprint Network
GDP	Economic growth	GDP per capita (constant-2015/ Dollars)	WDI
NREC	Non-renewable energy consumption	Fossil fuel consumption-TWh	OWID
FG	Financial Globalization	KOF index of FG	"KOF" Swiss Economic Institute
ICT	Information and communications technology	Index of fixed telephone subscriptions and mobile cellular-subscriptions based on (per 100 people) and individuals using the Internet (share of population) created by Principal Component Analysis (PCA) analysis.	WDI

OWID and WDI are our world in Data and World Development Indicators, respectively

3.1. Stationery and co-integration tests

This work uses Augmented Dickey-Fuller (ADF) to assess and address the stationarity issue. However, conventional unit root assessments ignore structural data (SD). To address this issue, the current paper employed Perron–Vogelsang (PV) proposed by Perron Vogelsang (1993), which allows for one structural break date. To explore the interaction among the examined variables, the present work utilized the A-ARDL approach as proposed by Sam et al. (2019). In the classical ARDL approach, an $F_{\text{statistic}}$ on all the lagged-level variables ($H_0: \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$), and a $t_{\text{statistic}}$ on the lagged level-dependent studied variable, ($H_0: \gamma_1 = 0$), are used to capture the co-integration. McNown et al. (2018) and Sam et al. (2019) propose additional $F_{\text{statistic}}$ ($H_0: \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$) on the lagged independent variables. Hence, the augmented ARDL combines three statistical tests: (i) $F_{\text{statistic}}$ for both dependent and independent variables and $t_{\text{statistic}}$ for the dependent variable, offering strong evidence to confirm co-integration among the study variables. (Sam et al., 2019).

The critical values (CVs) in the ARDL testing combine the integration features of integration for each studied series, utilizing procedures of the bootstrap ARDL method. This procedure leads to solving the stability problem in the outcomes of conventional co-integration approaches. For instance, the CV of the conventional ARDL approach allows for only one tested variable to be endogenous, whereas, in the upgraded ARDL test, the CVs allow for the endogeneity of tested variables (Jin et al., 2024). This approach is examined and formulated as follows:

$$\Delta \ln LCF_{it} = \alpha_0 + \sum_{i=1}^r \beta_1 \Delta \ln GDP_{t-j} + \sum_{i=1}^r \beta_2 \Delta \ln NREC_{t-j} + \sum_{i=1}^r \beta_3 \Delta \ln ICT_{t-j} + \sum_{i=1}^r \beta_4 \Delta \ln FG_{t-j} + \gamma_1 \ln GDP_{t-j} + \gamma_2 \ln NREC_{t-j} + \gamma_3 \ln ICT_{t-j} + \gamma_4 \ln FG_{t-j} + \omega ECT_{t-1} + \varepsilon_{1t} \quad (2)$$

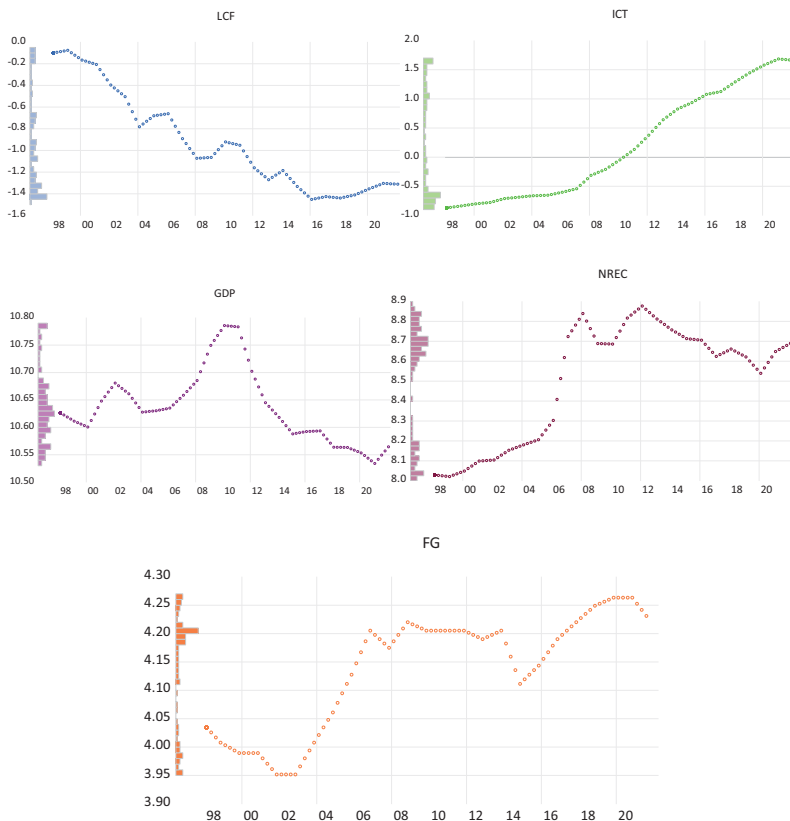
In above equation, ε_{1t} means the error-term; $(\beta_1, \beta_2, \beta_3, \beta_4)$ indicates the coefficients of the study variables in the short period; $\gamma_1, \gamma_2, \gamma_3$ and γ_4 represent coefficients in the long period; r represents optimal lags. We apply some diagnostic assessments to confirm the stability of the employed models. In this context, we use RESET, the ARCH, the normality, and the heteroscedasticity assessments to address the correlation and normality issues. Further, we use CUSUM and $CUSUM^{\text{square}}$ assessments to confirm the stability of the study models. We use Canonical Cointegrating Regression (CCR) and Fully Modified-OLS (FM-OLS) approaches to confirm the main findings of ARDL in the long run.

4. EMPIRICAL RESULTS

This section reports on the summary of descriptive statistics of the study variables in log, as reported in Table 2. The summary of descriptive statistics indicates that mean of LCF is -0.9255. While, the mean of ICT, GDP, NREC and FG are -0.0152, 10.6386, 8.5013, and 4.1359. Along with the descriptive statistics, the trend of the variables used for the analysis is also presented in Figure 1.

Table 2: Descriptive statistic outcomes

	"Mean	Median	Maximum	Minimum"	SD
LCF	-0.9255	-1.0291	-0.0784	-1.4535	0.4429
GDP	10.6386	10.6299	10.7853	10.5337	0.0650
NREC	8.5013	8.6400	8.8756	8.0198	0.2921
ICT	-0.0152	0.3831	1.9983	-3.5384	1.5461
FG	4.1359	4.1859	4.2627	3.9512	0.1011

**Figure 1.** The tested variables in plots

Before estimating the connection among the study variables, we evaluate the stationarity and cointegration issues. In this context, we use the Augmented Dickey-Fuller test (ADF) and the Perron and Vogelsang (PV) structural breaks unit root assessment to evaluate the stationarity issue. The outcomes of these tests are displayed in Table 3, which indicates that all the variables (LCF, GDP, NREC, ICT, and FG) are statistically stationary at first difference. PV test also unfolds specific dates of structural breaks of the tested variables, for instance, the structural break dates for LCF, GDP, NREC, ICT, and FG are 2013Q3, 2017Q2, 2006Q1, 2007Q2, 2015Q1, respectively. These changes may be attributed to political and economic crisis. After addressing the unit roots issue, we use AARDL

approach to evaluate the co-integration issue among the study variables. The findings from AARDL of co-integration are reported in Table 4. The outcomes illustrate that overall F_{Stat} is 19.33116, which is higher than the CV of Narayan. Similarly, the comparison of regressors *overall* F_{Stat} , t_{Stat} for dependent variable and F_{Stat} for independent variables exceed Narayan et al. 2005, Pearsan (2001), and Sam et al. (2019) CV, indicated the presence of cointegration. Thus, cointegration among the study variables is validated in the study model.

Table 3: Outcomes of PV and ADF tests

Variables	PV_{test}	ADF_{test}	
Level	$Test_{Statistics}$	D_{SB}	$Test_{Statistics}$
LCF	-3.381992	2001Q1	-2.025681
GDP	-3.484312	2007Q1	-2.248402
NREC	-3.765001	2006Q1	-2.020885
ICT	-1.447981	2014Q3	-0.954027
FG	-2.049957	2008Q4	-2.418609
First difference			
LCF	-6.068641***	2013Q3	-4.007733**
GDP	-10.31817***	2017Q2	-4.796458***
NREC	-5.372225***	2006Q1	-3.435120**
ICT	-11.08937***	2007Q2	-6.746826***
FG	-11.02284***	2015Q1	-3.733715**

** and *** represent the significance levels at "5 and 1 %" levels. D_{SB} implies dates of structural-break.

Once the integration order of the variables has been specified through unit root tests, we proceed to the analysis's next phase, the cointegration test. First, we use the novel AARDL approach. The test findings and CV are presented in Table 4. The findings show that the overall "F-statistic, F-statistic on independent variables, and t-statistic on the dependent variable" exceed CV at a significance level of 1%, confirming that cointegration among GDP, ICT, NREC, FG and LCF are valid.

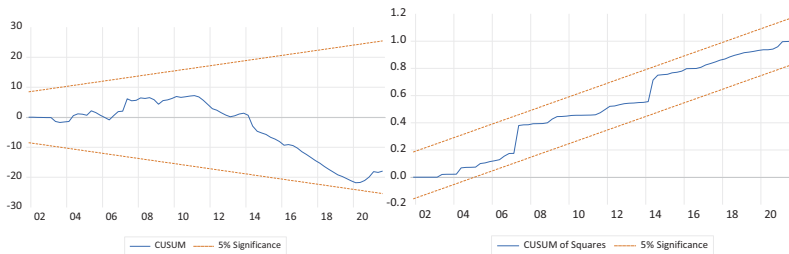
We use the ARDL assessment to estimate short and long linkage among the study variables. Further, we use some diagnostic evaluations that are displayed in Table 5. The findings of these assessments confirm the existence of normal distribution and the absence of heteroscedasticity and serial correlation. Further, the stability of the tested models was confirmed using CUSUMsq and CUSUM tests (Figure 2). The outcomes of AARDL show that link among GDP and LCF is negative in both the long and short run. A one percent increase in GDP reduces LCF by 0.173 in the short run and by 1.058 in the long run. These findings suggest that the economic growth of Oman negatively affects ecological sustainability by decreasing LCF.

Table 4: AARDL outcomes

Test stat							
$F_{overall}$		$t_{dependent}$				$F_{independent}$	
19.33116		-6.409900				24.09794	
CV	1%	5%		10%			
Statistics	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	Reference
$F_{overall}$	4.40	5.72	3.47	4.57	3.03	4.06	Narayan – CV (2005)
$t_{dependent}$	-3.96	-4.96	-3.41	-4.36	-3.13	-4.04	Pearsan-CV (2001)
$F_{independent}t$	3.40	5.68	2.40	4.31	1.97	3.62	Sam et al. CV (2019)

Table 5: Diagnostic analysis

Test/Models	Model LCF
Heteroskedasticity	1.624(0.20)
Normality assessment	1.312(0.51)
Ramsey-Reset	1.065(0.29)

**Figure 2:** CUSUM and CUSUM -SQ of LCF model

In the connection among ICT and LCF, we found that ICT has positive and significant effects on LCF. One surge in ICT promotes LCF by 0.093 in the short term and 0.571 in the long term, suggesting a positive role of ICT adoption in the context of Oman in promoting ecological sustainability. Regarding FG impacts, we identified a statistically significant linkage among long-term and short-term. A one percent increase in FG supports environmental sustainability by 0.290 and 1.055 percent in short and long terms, respectively. On the other hand, the coefficient estimates from AARDL suggest that Oman's increasing level of non-renewable energy negatively affect the environment in Oman. A 1 % increase in NREC in Oman mitigates the level of LCF by 0.220% and 1.346% in short and long period as

presented in Table 6. To confirm the findings of ARDL, we use FMOLS and CCR tests. The findings of these tests are displayed in Table 7, which shows that ICT, and FG have a positive effect on LCF, indicating that an increase in ICT and FG promote ecological sustainability by increasing LCF. Meanwhile, the findings show that an increase in NREC and GDP adversely affects the environment by decreasing LCF. These outcomes confirm the primary outcomes of ARDL long-run coefficients.

Table 6: ARDL method analysis

Variable	Coefficient	t.Statistic	Prob.
Short run			
GDP	-0.173509	-0.750563	0.4551
NREC	-0.220705***	-7.852691	0.0000
ICT	0.093662***	4.669411	0.0000
FG	0.290996***	3.248460	0.0017
Long run			
GDP	-1.058742***	-3.223053	0.0018
NREC	-1.346735***	-17.96921	0.0000
ICT	0.571520***	4.282305	0.0001
FG	1.055455**	1.912567	0.0593
ECT _{t-1}	-0.163882***	-3.223053	0.0018

*, ** and *** represent the significance levels at "10, 5 and 1 %" levels

Table 7: Outcomes of FMOLS and CCR tests

	FM-OLS			CCR		
	Coefficient	t_{stat}	PV	Coefficient	t_{stat}	PV
GDP	-0.725316**	-2.050054	0.0436	-0.820938*	-1.773549	0.0799
NREC	-0.560291***	-4.716380	0.0000	-0.570204***	-4.070320	0.0001
ICT	0.358052***	2.930779	0.0044	0.578042***	5.361193	0.0000
FG	1.063959***	2.656802	0.0095	1.628612***	7.514886	0.0000

*, ** and *** represent the significance levels at "10, 5 and 1 %" levels

5. FINDINGS DISCUSSIONS

This study aims to assess the impact of economic growth, fossil fuel energy, ICT, and FG on ecological sustainability. The study found that GDP has a negative effect on the environment by decreasing the level of LCF. The findings of this work are not in line with Mahmood et al. (2022) in the context of GCC and Naz et al. (2024) in the context of some Asian countries. These findings suggest that economic growth in context of Oman can drive more development and potentially lead to more fossil fuel use, thus playing a negative role in ecological sustainability. On the other hand, the findings show that an increase in non-renewable energy adversely affects the LCF, indicating the adverse effect of non-renewable energy on ecological quality. The outcomes are in line with Rai et al. (2025) for some selected countries, Zhang et al. (2024) in the context of China. In this context, the government in Oman must adopt more green strategies to reinforce ecological sustainability by encouraging clean investment and mitigating fossil fuel use.

Likewise, the study reports that ICT positively affects the environment by increasing the LCF. The findings support the study of Wen et al. (2025) in the case of BRICS countries, Yi et al. (2025) in the case of China, and Islam et al. (2023) in the context of GCC economies. These outcomes may explained to fact that Oman has faced significant improvement in ICT sector over the last decades. According to the Oman vision 2024, it aims to promote economic transformation and to reinforce the quality of life by improving the ICT infrastructure that can promote green investment and efficient technologies. Conversely, the findings are contrast with some empirical works that suggest, such as Aydin et al. (2025), who found that ICT has an adverse effect on ecological sustainability. However, ICT adoption has a generally positive role in promoting environmental quality by increasing the LCF via reduction in energy intensity and promoting green investment and technologies. However, ICT development plays a positive role in reshaping social behavior, with individuals increasingly inclined to replace traditional products consume high levels of fossil fuel to green products (Wang et al.,2024), this ICT effects represents the most direct effect of ICT on ecological sustainability and called non-materialization impact of information and communication technology (Charfeddine et al.,2024).

On the other hand, the work illustrates that FG has a positive effect on LCF. The findings support the study of Ali et al. (2025) in case of the top ten nuclear energy consumer economies and Ximei et al. (2025) in the context of APEC. At the same time, the findings are not in line with Le and Ozturk (2020). FG can play a positive role in transferring green investment and technologies among the economies and empowering the countries to reinforce ecological sustainability. Hence, by encouraging FDI in green investment and technologies, increasing environmentally friendly technologies, and removing the restrictions on green foreign investment. All these factors positively affect the ecological sustainability in the country. Hence, more encouraging environmentally friendly investment through different financial incentives, such as low tax and interest rates, and other financial incentives, will achieve sustainable development in the country.

6. CONCLUSION AND IMPLICATIONS

6.1 Conclusion

The prime objectives of the Oman version 2024 are enhancing financial sustainability, developing ICT, and focusing on transitioning to a low-carbon economy. In this regard, ensuring green development is crucial to achieving the 2024 vision. To this end, this study examines the short and long-term interaction among ICT, FG, and ecological sustainability. To capture environmental sustainability, we use the novel indicator of load capacity factor (LCF). This indicator reflects both the supply and demand aspects of nature, offering strong evidence to capture ecological sustainability. Using advanced econometric methods, we found that ICT has a positive effect on the environment by increasing the LCF in both the short and long term. This effect remains constant using other robust tests. Further, we found that FG plays a positive role in ecological sustainability in the context of Oman. Overall, the results emphasize the potential role of ICT and FG to promote environmental sustainability in Oman. FG in Oman is characterized by increasing integration with international financial markets, driven by the country's initiatives and the growth of financial and non-financial institutions in Oman. Besides, the country is actively developing its ICT sector, with a strong emphasis on digital transformation. The government has seen significant growth in internet access in Oman, with 98% of households connected. It is focused on promoting digital infrastructure and green technologies to support achieving the main goals of Oman Vision-2040, particularly achieving net-zero carbon emissions by 2050. These findings suggest that financial incentives and green ICT can play a positive role in supporting ecological neutrality by stimulating green investments and technologies.

6.2 Implications

Based on the study outcomes, a set of suggestions is offered for the Omani government and policymakers. First, Oman should continue to implement joint strategies and tools on green production and consumption, including the development of the ICT sector. For example, policymakers have to offer continuous financial incentives and support for green ICT implementation. Further, they must strengthen the green innovation systems in the markets and support sustainable, friendly technologies. Second, a solid foundation of ICT infrastructure can offer a favorable environment for green ICT development and reinforce the ecological quality. Therefore, policymakers should support the construction of ICT infrastructure, including smart grids, energy-saving measures in telecommunication networks, and the Internet of Things. Third, as FG plays a positive role in enhancing the environment, the government should be more integrated into the global community by facilitating more green foreign capital inflows and removing any restrictions on green investment. In this regard, governments should design more policies so that they can attract foreign investment related to green energy and technologies, such as low taxation and financial incentives. Further, the financing sectors can introduce green energy financial tools such as green bonds and stocks to promote the ecological sustainability in context of Oman.

6.3. Limitations and Future Research

This work has some limitations that suggest directions for future empirical studies. The generalizability of the outcomes of this work is restricted as the study is focused on Oman. Future empirical works can

offer more empirical evidence on the connection among ICT and LCF in other GCC countries. Likewise, longer datasets of ICT, FG, and LCF, as they become available, may help assess the enduring effects of ICT and FG on LCF. Future empirical works may explore the role of other economic and environmental factors, such as green ICT, on ecological sustainability. In addition, the study used augmented ARDL to capture the linkage among ICT, FG and LCF. Future studies can adopt other method such as nonlinear ARDL to capture asymmetric effect of the tested variables on LCF in context of Oman.

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