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Lab Report

Energy Cost Comparison in Two-Bay NAS Systems

QNAP TS-233 (entry-level) and QNAP TS-264 (advanced)

Author: Igor Misko, Senior Product Marketing Engineer,
Business Development Storage Products,
Toshiba Electronics Europe GmbH

Introduction

Network Attached Storage (NAS) systems have become a cornerstone for enterprises, small businesses, and home users seeking reliable, centralized data storage. Typically, NAS devices go beyond simple file storage; thanks to integrated redundancy mechanisms such as RAID (redundant array of independent disks or, historically, redundant array of inexpensive disks), they help mitigate the risk of data loss caused by hardware failures.

NAS solutions vary widely in specification - from basic one- or two-bay models offering essential network and storage functionality to advanced multi-bay rackmount systems designed for enterprise-level operations.

At the entry level, consumer and semi-professional users often opt for two-bay systems configured in RAID 1, which mirrors data across two hard drives to protect against drive failure. Even within this category, NAS units differ significantly in features. Basic models typically offer simple data storage and a single 1GbE (Gigabit Ethernet) connection - adequate for most home-office networks. Enhanced models, however, incorporate more powerful processors to support applications such as media servers or surveillance systems and may include faster network interfaces (e.g., dual 2.5GbE ports). Despite these differences, the fundamental storage performance of two HDDs in RAID 1 remains consistent.

Advanced NAS systems come with higher hardware specifications, increased power consumption - especially when operating 24/7 - and require greater technical knowledge for setup. Given rising energy costs, users should carefully assess whether they truly need higher network throughput and additional features.

Picture 1: QNAP TS-264 (left) and TS-233 (right) in the Toshiba HDD Innovation Lab

To assist in this decision, Toshiba's HDD Innovation Lab evaluated two popular two-bay NAS models using identical NAS-grade HDDs in different configurations: QNAP TS-233 (entry-level) and QNAP TS-264 (advanced). For this study, desktop-class NAS units were provided by our partner QNAP (Quality Network Appliance Provider).

Both units can accommodate two HDDs, operating in a mirrored RAID 1 configuration, and provide data storage to the attached network. However, all further specifications and functionality differ considerably:

	TS-233	TS-264
CPU	Cortex-A55 2.0GHz	Celeron® N5095 2.9GHz
Memory	2 GB	8 GB
HDD	2x Non-Hot-Swap	2x Hot Swap
SSD	no	2x m.2 2280
SSD Cache	no	optional
PCI-e Slot	no	1x Gen3 x2
HDMI	no	HDMI 2.1
USB2	2x	2x
USB3	1x USB 3.2 Gen 1	2x USB 3.2 Gen 2
LAN	1x 1Gbps	2x 2.5Gbps

Table 1: Comparison between the QNAP TS-264 and TS-233 2-Bay NAS Systems

The QNAP TS-233 is an entry-level two-bay NAS designed primarily for home users and basic backup tasks. It supports RAID 1 for data redundancy and connects via a single 1GbE port. Powered by an ARM® Cortex®-A55 quad-core processor (2.0GHz) and 2GB of non-expandable RAM, the TS-233 offers just enough resources for essential NAS functions. Application support is limited compared to higher-end models, but this minimalistic design results in low power consumption: QNAP quotes it on its website as around 10.8W during operation and 3.4W in standby. (https://www.qnap.com/en/product/ts-233/specs)

In contrast, the QNAP TS-264 targets power users and small offices. It features an Intel® Celeron® N5095 quad-core processor (up to 2.9GHz), 8GB DDR4 RAM (expandable to 16GB), and two 2.5GbE ports, enabling significantly faster network throughput. The TS-264 also includes two M.2 NVMe slots for SSD caching and a PCIe® Gen 3 x2 expansion slot, allowing upgrades such as 10GbE networking. Its QTS operating system supports a wide range of applications, including virtualization, multimedia streaming, and surveillance - features typically found in multi-bay enterprise systems. However, these capabilities come at the cost of higher energy usage: QNAP states it as approximately 29W under load and 18W in standby. (https://www.qnap.com/en/product/ts-264/specs)

The HDDs

For the HDD Innovation Lab evaluation, we used the Toshiba NAS HDD model N300 with a popular capacity of 8TB (model number HDWG780 with firmware level 0501). These 3.5-inch N300 NAS Hard Drives are designed for NAS and other high-performance storage systems. They are optimized to meet the reliability, endurance, performance, and scalability requirements of 24/7 high-capacity storage for personal, home office, and small business use. The N300 is available in capacities up to 22TB.

Picture 2: Two Toshiba N300 NAS HDDs

	Model	HDD	Power Consumption: Off (Measured)	Power Consumption: Idle (Measured)	Power Consumption: Active (Measured)
Professional 2-Bay NAS	TS-264	2x N300 8TB	1.6 W	27.0 W	33.0 W
Entry-Level 2-Bay NAS	TS-233	2x N300 8TB	1.0 W	5.0 W	23.0 W

Table 2: NAS Power Consumption Measurements

The power consumption of the single N300 8TB HDD unit itself was measured as 10.1W under a full sequential read/write workload.

NAS Power Consumption Measurements

Both NAS systems were connected to a 1GbE switch. This naturally limits the performance of the TS-264 model, but the target is to compare the energy cost of both systems under the same conditions in a (home-) Gigabit Ethernet environment.

Power measurements were taken in three states:

- **Off:** NAS switched off
- **Idle:** No data access or GUI activity
- **Active:** Full sequential read/write workload

For reference, we also measured the power consumption of the power supply unit with the NAS switched off (see Table 2).

With only 5W in idle mode, the TS-233's host system consumes minimal power; even under load, its draw of 23W is dominated by the two HDDs (10.1W each). In contrast, the more powerful TS-264 system draws about 30W, even in idle mode.

Energy Cost

We estimated the energy cost of both systems under the following conditions:

Assumed electricity price in Germany	0,35 Euro/kWh
Active/Idle Ratio	0,20 (20% active)

Table 3: Energy Cost Base and Active/Idle Ratio

A 20% active ratio is typical for home NAS usage, including daily backups and occasional file access (see Table 3).

Due to its higher idle power, the professional TS-264 model consumes about 170kWh more per year than the TS-233 (see Table 4).

Energy Cost Savings TS-233 over TS-264 for 5 Years:	300,5 Euro

Table 5: Five-Year Energy Cost Savings

With a life/service time of five years, the TS-233 offers approximately €300 in energy savings compared to the TS-264, assuming identical operation/usage and a 1GbE network connection.

Conclusion

When selecting a NAS solution, users should balance functionality against energy consumption and cost. For environments requiring only basic storage and 1GbE connectivity, typical of most homes, an entry-level model such as the QNAP TS-233 offers sufficient performance with significantly lower power usage, reducing annual energy costs by up to €60.

Conversely, advanced models like the QNAP TS-264 deliver enhanced processing power, faster network interfaces, and support for applications such as media streaming and surveillance, but at the expense of higher energy consumption and complexity.

Ultimately, while both systems provide reliable RAID 1 protection, the choice should reflect actual network requirements and application needs rather than feature availability alone.

	Model	HDD	Energy Consumption: Idle	Energy Consumption: Active	Energy Consumption: Average	Cost/year
Professional 2-Bay NAS	TS-264	2x N300 8TB	236,5 kWh/year	289,1 kWh/year	247,0 kWh/year	86,46 Euro
Entry-Level 2-Bay NAS	TS-233	2x N300 8TB	43,8 kWh/year	201,5 kWh/year	75,3 kWh/year	26,37 Euro

Table 4: Annual Energy Cost Comparison

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Note of thanks to our partners

"Important to the success of this lab report has been the collaboration. I want to thank our partner QNAP for the support on this project, as they contributed with the NAS units and valuable support and advice. Together with our Toshiba NAS Hard Disk Drive models, we were able to evaluate the exact amount of energy consumption in direct comparison and give valuable monetary advice to users."

Igor Misko
Senior Product Marketing Engineer
Business Development Storage Products
Toshiba Electronics Europe GmbH

Interested in performing a test in our HDD Innovation Lab yourself or planning a visit?
We'd be happy to support you.

Toshiba Electronics Europe GmbH

Hansaallee 181
40549 Düsseldorf
Germany

info@toshiba-storage.com
toshiba-storage.com

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