An Economic Evaluation of Future Electricity Use in Irish Data Centres

Bryan Coyne [1] (brcoyne@tcd.ie), Prof. Eleanor Denny [1] (dennye@tcd.ie)

Department of Economics, Trinity College Dublin (Ireland) [1]

Introduction

Universal internet access is one of the UN Sustainable Development Goals[1], with estimates that four billion people are currently without access[2]. Research has identified links between economic growth and the availability of internet[3].

In an increasingly connected society, "cloud-based" applications, video content and real-time transactions have driven demand for connectivity[4]. As a result, data centres have become a critical piece of infrastructure.

In 2015, data centres consumed an estimated 2% of global electricity and 3% of emissions[5]. Concerns surrounding energy prices, electricity generation and related emissions have spurred interest in lowering data centre energy consumption.

Most of the data centre energy consumption is attributed to powering and cooling computer servers. Where used, one third of this may be due to the mechanical air chiller, used to cool air for heat removal[6].

Objectives

This paper models future data centre electricity consumption attributable in the Republic of Ireland, a popular location for data centres.

We consider a scenario where firms consider adopting a more energy efficient server cooling technology. We assume that this negates the need for mechanical air cooling, reducing electricity consumption by a third. Results are centred on three questions:

1. What is the effect on electricity demand for the data centre sector?
2. What is the effect on the national electricity demand?
3. What is the effect on sectoral and national generation-related CO_2 emissions?

References

1. UN, 2015. Transforming our world: The 2030 agenda for sustainable development
2. World Economic Forum, 2016. Internet for All: A Framework for Accelerating Internet Access and Adoption.
3. Koutroumpis, P., 2009. The economic impact of broadband on growth: A simultaneous approach. Telecomm. Policy 33
4. McKinsey, 2010. Energy efficiency : A compelling global resource, McKinsey Sustainability & Resource Produtivity.
5. Bawden, T., 2016. Global warming: Data centres to consume three times as much energy in next decade, experts warn. http://www.independent.co.uk/environment/global-warming-data-centres-to-consume-three-times-as-much-energy-in-next-decade-experts-warn-a6830086.html
6. Garimella, S. V., Persoons, T., Weibel, J., Yeh, L.T., 2013. Technological drivers in data centers and telecom systems: Multiscale thermal, electrical, and energy management. Appl. Energy 107
7. Brander, M., Sood, A., Wylie, C., Haughton, A., Lovell, J., 2011. Electricity-specific emission factors for grid electricity, Ecometrica

Methodology

Forecasts of data centre capacity and national electricity demand are obtained from EirGrid, the Irish Transmission System Operator (Figure 1), and are used to model two scenarios of market diffusion from 2015 to 2026, with adoption beginning in 2017:

New Only Diffusion (ND): Upcoming data centres adopt the more efficient cooling from when they open.

All Diffusion (AD): Upcoming and existing data centres adopt more efficient cooling. The rate of adoption follows an s-shaped curve of technological adoption over time (Equation below). Results (dashed lines) are compared to EirGrid forecasts. Electricity-specific emissions factors are used to calculated the CO_2 saved through this adoption.

$$\text{Rate of adoption: } \lambda_{it} = \left(1 + \frac{t_{ie} - t_i}{t_{ie} - t_m}\right)\left(\frac{t_i}{t_{ie}}\right)^{\frac{t_{ie}}{(t_{ie} - t_{im})}}$$

Results

Figure 1

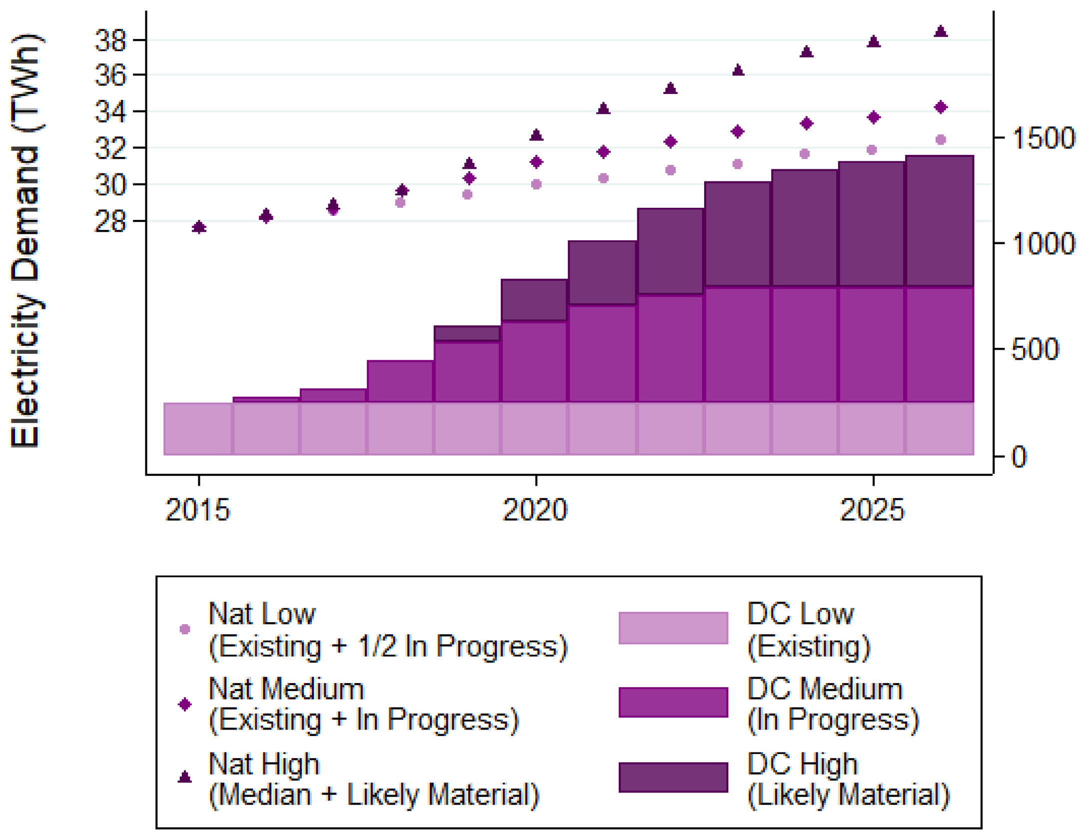
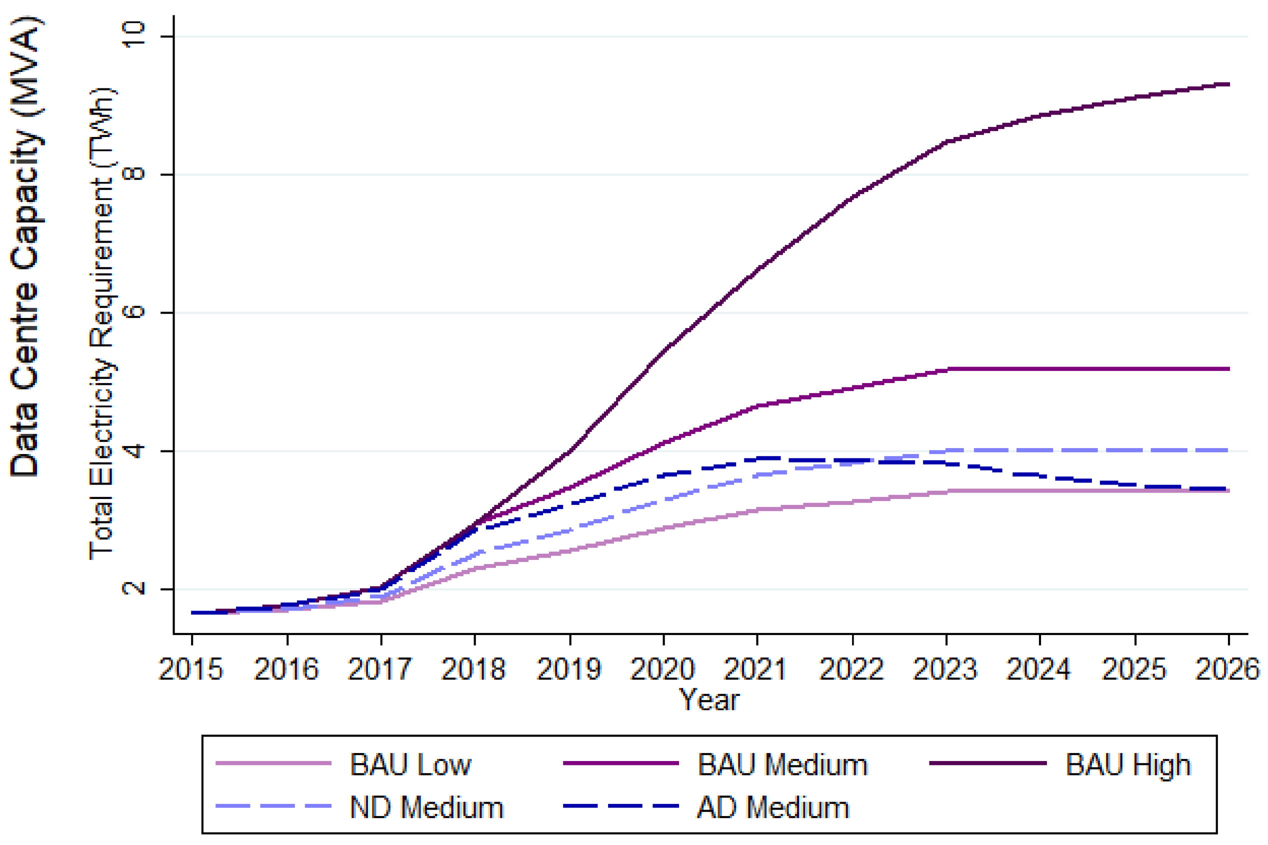


Figure 2



In both scenarios data centre electricity consumption is expected to be ~19% lower from 2017-2026 relative to the EirGrid (BAU Medium) scenario. This reduction is initially larger for the ND case. Nationally, this equates to a 2.4% fall in electricity consumption over the same period. An illustrative estimate of sectoral emissions indicates a fall by approximately 19%. This result will be a focus of future work.

	Sectoral electricity consumption in 2026	National electricity consumption in 2026	% of national electricity consumption in 2026	CO2 Emissions (Mt CO_2eq) 2015-2026 EF: 0.5661 kgCO2/kWh[7]
EirGrid median scenario	5.19 TWh	34.2 TWh	15.1%	26.20
Only new data centres	22.9% lower	3.4% lower	12.1% (-3%)	21.22
All data centres	33.3% lower	5% lower	10.6% (-4.5%)	21.14

Conclusions

Data centres play a crucial role in the modern economy. This paper highlights the industry and policy interest in data centre electricity consumption. It provides a method to study technology adoption over time that reflects more realistic adoption patterns.

A novel case study for the Irish data centre sector is conducted using relatively few assumptions and limited data. The key result is that savings in electricity consumption (and related emissions) are influenced by how quickly firms adopt new technologies.

A copy of the paper is available on our project site: datacentresresearch.com

Acknowledgement

This publication has emanated from research conducted with the financial support of Science Foundation Ireland under the SFI Strategic Partnership Programme Grant Number SFI/15/SPP/E3125. The opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Science Foundation Ireland.