ChatGPT

A Comparative Analysis of AI as a General Purpose Technology: Steam, Electricity, Internet, and AI

Introduction

General Purpose Technologies (GPTs) are foundational innovations that drive broad economic and social transformations. Economists define GPTs by three key criteria: **pervasiveness**, **continuous improvement**, and **innovation spawning** [1]. In other words, a GPT spreads to most sectors, gets cheaper and more effective over time, and catalyzes complementary innovations across the economy [1]. Classic examples include the steam engine, electric power, and the internet – each of which eventually touched nearly every industry and led to waves of follow-on inventions. GPTs "alter pre-existing economic and social structures" at a fundamental level [2].

Today, artificial intelligence (AI) is increasingly viewed as the next GPT. It exhibits rapid improvements in capability, from language understanding to decision-making, and its applications are proliferating across fields from medicine to finance. Comparing AI with past GPTs is timely: it helps us gauge AI's potential impact and the trajectory we might expect by learning from history. The steam engine, electrification, and the internet each transformed economies **after an initial period of slow adoption and skepticism** – a pattern that may also apply to AI. Indeed, experts argue generative AI is a "game-changing" GPT and may spur change even faster than its predecessors due to its digital accessibility [3]. In this report, we analyze AI alongside steam, electricity, and the internet to understand how AI functions as a general-purpose technology and why this comparison is relevant for anticipating its role in the economy.

The Four GPTs: Historical Overview and Essence

Steam Power

Steam power was the catalyst of the First Industrial Revolution, harnessing thermal energy (from burning coal) to produce mechanical work (torque). Early steam engines converted heat into motion, enabling machines to perform physical labor on an unprecedented scale. This generalized power source could be applied across domains: pumping water out of mines, powering factory machinery, driving locomotives and steamboats for transportation, etc. In effect, steam engines supplanted muscle power (human or animal) and freed industry from geographic constraints like water streams or wind. **By the mid-19th century, steam engines were running factories, allowing deeper mining, and moving entire transport networks** [4]. James Watt's improvements in the late 1700s (separate condenser, rotary motion) greatly increased efficiency and practical applications of steam engines, leading to their spread in textiles, metallurgy, and railroads. Steam power's essence is mechanization – it provided a **universal means to convert fuel into useful work**, bringing about mass production and faster travel.

However, steam's economy-wide impact took time. Early engines (Newcomen's in 1712, Watt's in 1769) were inefficient and expensive. Adoption was initially slow and met with skepticism. Many 18th-century entrepreneurs stuck with water wheels or horse power, as steam's advantages were not yet overwhelming

[5]. It wasn't until the mid-1800s, with higher-pressure engines (e.g. the Corliss engine) and falling coal prices, that steam power became highly cost-effective and pervasive [6]. By 1870, steam power was approaching its heyday, driving rapid productivity gains in manufacturing [7] [8]. Steam power thus exemplified a GPT: eventually pervasive (powering factories, trains, ships), continuously improved (from 1% efficiency to much higher over decades), and spawning innovations like steam locomotives and industrial machinery. It "was the icon of the Industrial Revolution and a prime example of a GPT" that fundamentally changed production and transportation [8].

Electricity

Electricity became the driving force of the Second Industrial Revolution, serving as a *medium for energy transmission* rather than a fuel. Unlike steam engines (which had to burn fuel on-site), electricity could be generated centrally (in power plants) and sent through wires to anywhere it was needed. This made energy **fungible and ubiquitous** – factories, offices, and homes could tap into a grid instead of maintaining their own engines. Electricity thus decoupled power from location and load: a myriad of devices could be powered by the same electric supply. Its earliest transformative use was lighting. The incandescent bulb (commercialized by Edison in 1879) replaced gas lamps and candles, **bringing safe, bright light to streets, factories, and homes**. Electrification extended working hours and improved quality of life by illuminating the night at the flick of a switch [9]. Soon after, electric motors began to revolutionize industry. By the 1890s–1910s, factories were installing small motors on individual machines, replacing large steam engines that drove machines via shafts and belts [10] [11]. This **flexible distribution of power** enabled factory layouts to be optimized (machines could be arranged by workflow instead of around a drive shaft) and greatly increased productivity [12].

Electricity's essence is that it is a *general-purpose energy carrier*: a form of power that can be converted into light, heat, motion, or chemical processes with minimal effort. It transformed domains as diverse as **manufacturing (electrified assembly lines and machine tools), transportation (trams, subways), communications (telegraph and telephone relied on electrical signals), and home life (appliances like refrigerators, radios, and washing machines)**. Few technologies have "changed pre-existing economic and social structures" as profoundly as electric power did [13] – it was pivotal in boosting productivity and living standards in the early 20th century. For example, as electrification spread in U.S. manufacturing from virtually 0% in 1880 to ~80% of mechanical drive by 1929, enormous efficiency gains followed [14] [15]. In fact, historians note that *electrical motors not only reduced energy costs, but also enabled greater output per unit of capital and labor by 1920–1930*, fueling faster economic growth [14]. Electricity was not just a better lamp or a faster engine – it was a **qualitatively different way to distribute energy**, spawning a host of new industries and innovations (electric appliances, mass communications, electronics, etc.) that were impossible in the age of steam.

The Internet

If electricity created a medium for transmitting energy, the **internet created a medium for transmitting information**. The internet (originating from ARPANET in the late 1960s and blossoming with the World Wide Web in the 1990s) enabled high-fidelity, instant communication across any distance. This represented a leap beyond earlier communications technologies. The telegraph (19th c.) could send textual messages over wires, but it was limited to short messages handled by operators, and the telephone (early 20th c.) enabled voice calls but in a one-to-one, analog fashion. The internet generalized digital communication: *any content – text, audio, images, video – can be encoded in binary and routed to any connected device globally*. It is often called the "network of networks" because it connects countless private and public networks into one global system using common protocols (TCP/IP). The result is near **real-time exchange of information** at practically zero marginal cost, enabling use-cases from email to e-commerce to streaming media. In essence, the internet became a **general-purpose information infrastructure** for society.

The transformations fueled by the internet have been sweeping. It drastically lowered the cost of obtaining and sharing information, which in turn restructured industries like news media, advertising, retail, finance, and education. **Geographic and organizational barriers to communication fell** – individuals and businesses could coordinate and collaborate worldwide with ease. New platforms emerged (the Web, search engines, social media) that redefined how people socialized, learned, and entertained themselves. Commerce changed via online marketplaces and supply-chain integration across continents. According to analyses, the internet's impact on economic activity has been "nothing short of transformative," touching virtually every aspect of life in developed countries [16]. By 2021, over 4.5 billion people were online, and internet-based services contributed heavily to GDP growth in the late 1990s and 2000s. For example, the late-90s ICT boom (computers + internet) is credited with a substantial productivity acceleration – **total factor productivity growth nearly doubled in the U.S. (to ~2% annually in the late 1990s)** as businesses adopted IT and internet-enabled processes [17] [18]. The internet's essence is enabling **instant, global coordination of information**, which spawned innovations like cloud computing, online markets, and digital media that simply had no precedent before this GPT.

Artificial Intelligence

Artificial Intelligence is now emerging not just as a piece of software, but as a *medium for cognition*. In other words, AI provides a general capability for perception, reasoning, and decision-making that can be deployed across many tasks – a parallel to how electricity provided a general capability for energy delivery. Modern AI (especially machine learning and its subfield, deep learning) is **fundamentally different from traditional computer programs**: instead of being explicitly programmed with fixed rules, AI systems *learn* from data, identifying patterns and developing their own rules. This means AI can handle complexity and ambiguity (recognizing images, understanding natural language, making predictions) that was impractical to hard-code. A well-trained AI model can **generalize** – e.g. having learned from millions of examples, it can respond intelligently to inputs it hasn't seen before (like a new sentence or a new scenario in driving). AI can also *adapt* and improve as it gets more data or feedback (continuous improvement in performance), and it can even **generate new content or solutions** (as seen in generative AI models producing text, art, or designs). Crucially, AI is *multi-domain*: the same underlying algorithms (neural networks, reinforcement learning, etc.) can be applied to vision, speech, gameplay, robotics, and more, rather than each domain needing a bespoke tool. This versatility is why many refer to AI as a general-purpose technology or "cognitive infrastructure."

It's important to note that AI is **not just another software application – it's more like a cognitive layer that can be incorporated into all software and devices**. Just as electricity became an invisible utility powering countless tools, AI can become an ubiquitous "intelligence" embedded in systems and products. For example, AI algorithms now filter spam emails, recommend what we buy/watch, optimize factory lines, assist in medical diagnosis, and even drive cars. This breadth underscores AI's general-purpose nature. AI can *abstract*: finding high-level representations of raw data (like abstracting "this is a cat" from pixel values), effectively compressing knowledge. It can take **multimodal inputs** – modern AI models like large multimodal models accept text, images, even audio together and make sense of them jointly, something humans do naturally but software never could until now. Advanced AI systems can also **take actions via**

tools (e.g. an AI agent calling APIs, controlling robots, or executing trades), which means they don't just compute answers but can *effect changes in the world*. Finally, an economic essence of AI is the **near-zero marginal cost of cognition**. Once an AI model is trained (often a costly process), using it to perform tasks is very cheap and infinitely scalable – you can deploy a chatbot to answer millions of inquiries without needing millions of human customer service agents. This dynamic – extremely low-cost prediction and reasoning at scale – is what makes AI potentially as transformative as past GPTs. *"Just as electricity transformed almost everything 100 years ago, I have a hard time thinking of an industry AI won't transform in the next several years,"* noted AI pioneer Andrew Ng, highlighting AI's anticipated pervasiveness [19] .

In summary, AI serves as a **general medium for intelligent behavior**. It is software that *writes itself* through learning, enabling it to tackle tasks that previously required human cognitive skills. This positions AI as a GPT on par with steam, electricity, and the internet – it is a technology that can eventually spread to most sectors, continuously improve in capability, and spur numerous complementary innovations (from smart assistants to autonomous vehicles and beyond).

Core Differentiators: Why These Were Not Just Improvements

Each of these four technologies represented a **qualitative leap over prior alternatives**, not merely a minor efficiency improvement. Here we outline what made steam, electricity, the internet, and AI fundamentally different from what came before:

- **Steam Power vs. Prior Power Sources:** Before steam, mechanical work was powered by muscle (human/animal), water wheels, or windmills. Those sources were limited by geography and intermittency – water and wind require specific locations and vary with weather, and muscle power is bounded by biology. Steam engines broke these limits. A steam engine could be built *anywhere* (only fuel and water needed) and run *continuously*. It offered **scale and consistency** of power that water/wind could not. For example, one early 19th-century steam engine could do the work of dozens of horses, on demand. Steam also allowed **mobile power** – locomotives and steamships could carry their energy source with them (coal), unlike a sail that depends on wind. In transportation, this was revolutionary: a steam locomotive could haul freight **faster and more reliably** than horse-drawn wagons or canal boats, irrespective of weather, thus shrinking travel times drastically. Importantly, steam power generalized **across domains**: the same engine design could pump in mines, grind grain, spin textile machines, and propel vehicles. This generality is a hallmark of a GPT. Steam wasn't just a slightly better pump; it was a new paradigm for obtaining mechanical work, triggering the factory system and rail network expansion. No prior single technology had such cross-cutting impact.

- **Electricity vs. Gas Lighting & Steam Engines:** Electricity distinguished itself by separating energy generation from use. Previous methods like gas lighting involved burning fuel at the point of use (each lamp had a gas flame), and factories powered by steam had a coal-fired boiler on-site. Electricity, in contrast, could be generated in large central stations (using coal, hydro, etc.) and *distributed* as a clean, versatile energy form to countless end-use devices. This meant **flexibility and convenience**: one grid powered factory motors, home appliances, streetcars, and lights alike. Compared to gas lamps, electric lights were **brighter, safer, and easier to control** (no open flames, no noxious fumes, instant on/off). Compared to steam engines driving factory shafts, electric motors were **modular and efficient** – factories no longer needed a single massive engine turning belts throughout the building (a setup prone to breakdowns that would halt the entire plant) [10] [11] .

Instead, dozens of small motors could independently drive machines; if one failed, others were unaffected, and power loss from long driveshafts was eliminated. This led to *higher productivity and less downtime*, as well as safer, cooler, better-lit working environments [12]. Additionally, electricity unlocked entirely new categories of products: telegraphs and telephones for instant communication (transmitting signals via electromagnetic currents was fundamentally different from courier or analog telegraph systems), as well as the radio and later television (broadcasting electromagnetic waves through the air). In sum, electricity's differentiators were **universality (one power source for any task), transmitability (wire distribution over distance), and precision/control (fine control of small devices)**. These made it far more than an incremental improvement over gas or steam – it was a platform on which 20th-century modern technology was built.

- **The Internet vs. Telegraph/Telephone:** The telegraph (mid-1800s) and telephone (late 1800s) were earlier communication breakthroughs, but the internet went beyond them in *scope and fidelity*. The telegraph could send text messages nearly instantly, but required skilled operators and was basically one-to-one (or one-to-many via printed telegrams) in a very limited modality (textual Morse code). The telephone added voice communication, which is higher bandwidth, but was still mostly one-to-one and analog (no easy way to store, search, or distribute information widely). The internet combined **global reach with digital format** and many-to-many connectivity. Any user on the internet can in principle reach any other, and one piece of content can be disseminated worldwide at negligible cost. Crucially, the internet is *packet-switched* and doesn't require a dedicated circuit for each call, enabling more efficient and robust communication than the telephone network. And because it is digital, the internet can carry **any media type** uniformly – text, images, audio, video all become just data packets. This convergence meant the internet subsumed functions of many older technologies (phone calls became Voice over IP, mail became email, radio/TV became streaming, etc.) and enabled **interactive and on-demand communication** (e.g. web browsing is user-driven, unlike one-way broadcast TV). Another differentiator is the **decentralized and open architecture** of the internet. Unlike the telephone network (largely controlled by telecom monopolies), the internet's protocols (TCP/IP, HTTP) are open standards, and the network is distributed. This allowed an explosion of innovation on the "edges" (think of the myriad of applications and websites created by anyone, not by a central telegraph/telephone company). The result was a level of **innovation spawning** far beyond prior communication tech – from e-commerce platforms to social networks to cloud computing, none of which were conceived in the telephone era. In short, the internet wasn't just a faster telephone or a digital fax; it was a *paradigm shift* to a connected digital ecosystem, enabling new modes of work (e.g. remote collaboration), new business models, and a massive information economy.

- **AI vs. Traditional Software:** Artificial Intelligence diverges from traditional software development in fundamental ways. Classical software is *explicitly programmed*: engineers write rules and logic line by line, and the program strictly follows that deterministic logic. This approach struggles with complex, fuzzy problems (like understanding natural language or driving a car in an unpredictable environment) because one cannot feasibly code all possible "if X then Y" rules. AI flips the script: instead of programmers writing the rules, they design systems that **learn the rules from data**. In machine learning, developers supply a learning algorithm and training examples; the system "figures out" the underlying patterns. As a result, AI systems can make **probabilistic inferences** and handle uncertainty by learning a model of the world, rather than relying on pre-defined logic. This yields flexibility: for example, a machine translation AI isn't programmed with grammar rules for every language pair; it *learns* to translate by observing millions of sentence pairs. Traditional software is mostly domain-specific and brittle outside its specified scope. AI, especially deep learning models, are more **generalizable** – the same algorithm (say a convolutional neural network) can be trained on vision tasks (identifying objects in images) or, with some adaptation, on audio tasks (speech recognition), etc. The ability to **absorb vast amounts of data and "experience" to improve performance** is unique to AI. Additionally, AI can compress knowledge in ways humans can't program manually – e.g. a large language model compresses linguistic and factual knowledge from trillions of words into a set of numerical parameters, which it can then use to generate answers or write code. Another difference is that AI's output is often **probabilistic** or ranked (it might give a list of likely interpretations, or produce a best-guess prediction with confidence level), whereas traditional software follows a fixed sequence of logical deductions that yield a single outcome. This probabilistic reasoning is actually a strength in messy real-world environments where there's ambiguity. AI also shines with **multimodal reasoning** – modern AI can link text, images, and other inputs together (for instance, captioning an image by "understanding" its visual content and generating a textual description). By contrast, legacy software would require completely separate systems to handle different data modalities.

Perhaps the most important differentiator is that AI can effectively **autonomize and scale cognitive tasks**. A traditional program might automate a repetitive calculation, but AI can *automate decision-making* in contexts that require intuition or complex perception (e.g. screening resumes, detecting fraudulent transactions, diagnosing diseases from scans). And once an AI model is trained, deploying it costs very little per additional unit of output – it's like having a million extra analysts at near-zero cost each. This is analogous to how electrification provided cheap mechanical power everywhere; AI provides cheap cognitive prediction and analysis everywhere. As economists put it, *AI "significantly lowers the cost of prediction," a core input to many business and life decisions* [20] [21]. Traditional software could crunch numbers as instructed, but AI can **predict** outcomes (what is the likely demand next month? which content will this user prefer? how might a protein fold?) and do so faster and more accurately than a human, transforming how decisions are made. In short, AI's learned, data-driven **adaptive behavior** and its generality across tasks make it a completely different breed from conventional software. It is not confined to a single application – it is better thought of as a *cognitive substrate* that many applications can be built upon or enhanced by. Just as electricity wasn't just another factory appliance but the power source for all appliances, AI is poised to be the intelligence that undergirds all kinds of tools and systems.

Comparative Table

To crystallize the similarities and differences of Steam, Electricity, the Internet, and AI as GPTs, the table below compares them across several dimensions:

GPT	Medium of Transformation	Domains Transformed	Adoption Curve	Initial Skepticism / Dismissal	Infrastructure Requirements	Core Ecor Leverage
Steam Power	Thermal energy → Mechanical work (torque)	Industry (factories, mining), Transportation (rail, shipping)	*Gradual 1700s start.* Steam engine introduced early 1700s (Newcomen); major diffusion in early 1800s Industrial Revolution; by late 19th c. widely adopted in industry [22] [23]. Growth impact peaked mid-1800s, then gave way to electricity.	Early engines were **inefficient, costly, and dangerous**. Many firms stuck with water or horse power for decades. Steam adoption was slow until Watt's improvements and cheaper coal. Critics in the 1700s questioned whether steam was worth the cost and risk (boiler explosions were feared). **"Steam was relatively slow to be adopted"**; conservative attitudes and high initial costs tempered enthusiasm [5].	Coal mining & distribution; boilers, ironworks to build engines; water for steam. Railroads and steamships required laying tracks, building ports. Skilled engineers for maintenance. Overall, a huge capital investment in steam locomotives, tracks, and factories was needed to fully utilize steam power.	**Mechaniz Scale:** Dra increased worker. Er **mass pro** and faste lowering goods an geograph Steam loc slashed tr (days to h integratin Factories steam ach economie beyond a productio contributi productiv it diffused overall it a ~0.2% to a labor proc growth in phases [24 initially, th significan It set the the mode industrial

Electricity	Electromagnetic energy (voltage in wires)	**Manufacturing** (electrified machinery, assembly lines), **Transportation** (trams, subways, electric vehicles), **Urban life** (lighting, elevators), **Consumer appliances** (refrigerators, radios, etc.)	*Faster uptake.* First power grids 1880s; by 1920, >50% of U.S. manufacturing power came from electricity; by 1929, ~78% [15]. Households: in 1910 few had electric service, by mid-20th century nearly all did in developed countries. The 1890–1930 period saw steep adoption in industry, then widespread home electrification by 1940s–50s.	Faced **doubts about safety and utility beyond lighting**. Gas companies disparaged electric light as unsafe; some thought early electric motors didn't justify cost if factories didn't re-organize. Initially, factories just swapped steam engines for one big electric motor, yielding little gain [26] [11]. Only after firms reconfigured production into *unit drive* (individual motors) did productivity surge, validating electrification. Also, AC vs DC "Current War" sowed public confusion. Overall, the *"productivity paradox"* of electricity meant its big economic benefits weren't immediate, causing skepticism in the 1890s that it was more than a	Central power stations (coal, hydro dams), a transmission grid of wires, transformers, etc. Urban electrification required massive infrastructure projects for generation and distribution. Also needed standardization of voltage/ frequency, and building wiring in factories and homes. Adoption depended on investments in electrical equipment (motors, lighting fixtures, appliances) and trained electricians.	**Universa** **Efficiency** provided **flexible p** any task - efficiency enabling **continuo** **manufac** chemical industries **products** (telecomm appliance It substar boosted p in the U.S electrifica estimated raised lab productiv by ~0.5% the early century [2 larger jun steam had It extende working d light), imp capital uti and spurr **economi** (elevators transit en modern c Electrifica to reduce costs and output pe made it a of the hig "roaring 1

GPT	Medium of Transformation	Domains Transformed	Adoption Curve	Initial Skepticism / Dismissal	Infrastructure Requirements	Core Econ Leverage
				fancy light source.		

The Internet	Digital information (data packets routed globally)	**Communication** (email, messaging, video calls), **Information distribution** (web, search engines, digital media), **Commerce** (online retail, banking), **Coordination** (enterprise software, cloud services, supply chain integration)	*Very rapid once introduced to public.* Proto-internet in 1970s (ARPANET) was limited to researchers. But from mid-1990s (Web browser era), adoption skyrocketed: ~16 million internet users in 1995 to **half a billion by 2001**, and over 5 billion today. In the U.S., internet use went from near 0 in 1990 to ~75% of households by 2010. Businesses integrated internet (email, websites) within a decade (mid-90s to mid-2000s). The diffusion globally was faster than any prior GPT (within ~20 years, a sizable portion of humanity was online).	Some early **dismissals as a fad**. In 1995, Newsweek ran an infamous piece calling the internet hype ("Why cyberspace isn't, and will never be, Nirvana"). Even esteemed economists were skeptical: *"By 2005, it will become clear the Internet's impact on the economy has been no greater than the fax machine's,"* wrote Paul Krugman in 1998 [28]. Many businesses initially didn't grasp the internet's potential (90s: "brick-and-mortar" retailers downplayed e-commerce). There were concerns the internet was insecure, or just a niche for tech enthusiasts. The dot-com crash in 2000 reinforced skeptics' views that the internet's transformative claims were overblown – but	Physical telecom networks (fiber optic cables, routers, undersea cables, cellular towers for wireless internet). Server infrastructure and data centers to host websites and services. Common protocols and standards (TCP/IP, HTTP) to interconnect systems. User devices: personal computers, and later smartphones, had to become common for the internet's benefits to reach individuals. Also required software infrastructure (browsers, email clients) and massive investment in backbone networks.	**Lowered Transacti Coordina** The intern drastically **the cost a informat exchange** yielded hu productiv enabling communi instant em days for l reducing intermed transactio online bo replacing agents). I **globaliza** small firm reach a w online – a improved efficiency transpare competiti new indus emerged advertisin software- service, g platforms economic The late 1 notable u productiv attributed IT and int adoption productiv jumped a the 1996- period) [2 the long r internet's

GPT	Medium of Transformation	Domains Transformed	Adoption Curve	Initial Skepticism / Dismissal	Infrastructure Requirements	Core Eco[nomic] Leverage
				only for a short time, as the internet continued to grow and ultimately proved its critics spectacularly wrong.		**effects** (v[...] growing a[...] users/con[...] connect) [...] giants an[...] how value[...] (think dat[...] platform-[...] economie[...] leverage i[...] people an[...] connect a[...] coordinat[...] instantan[...] across va[...] essentiall[...] *communic[...] to near-ze[...]* vastly acc[...] innovatio[...] knowledg[...] dissemina[...]

Artificial Intelligence	Software-based cognition (machine learning models and algorithms using data/ compute)	Potentially *all sectors*: **Knowledge Work** (content creation, customer service chatbots, translation), **Medicine** (diagnosis, drug discovery), **Finance** (algorithmic trading, risk modeling, fraud detection), **Manufacturing** (predictive maintenance, robotics vision), **Transportation** (autonomous vehicles), **Marketing** (personalized ads, demand forecasting) – anywhere tasks involve perception, prediction, or decision-making.	*Emergent, accelerating now.* AI research began in mid-20th century, but adoption was niche for decades (rule-based AI in specific applications). Modern AI (deep learning) took off in 2010s. By late 2010s, AI was in common use on smartphones (voice assistants, face recognition). The true mass adoption arrived with **Generative AI in 2022–2023** (e.g. ChatGPT reached 100 million users in 2 months, the fastest uptake of any consumer tech). Many firms are now integrating AI, but broad economic impact is just beginning. Experts suggest AI's	**Skepticism has cycled** with AI. In earlier decades, AI overhype led to "AI winters" (periods of disillusionment in the 1970s and late 1980s when grand promises weren't met). Many believed intelligence was so unique to humans that machines could not replicate it beyond narrow tasks. Even recently, some critics argue today's AI (like large language models) are "just autocomplete" or stochastic parrots, not true intelligence – implying they're a party trick that won't revolutionize anything. There are also **fears and dismissals**: some focus on AI's mistakes and say it can't be trusted in important matters, slowing adoption in areas like healthcare due to safety	Data infrastructure (very large datasets, data engineering pipelines), specialized hardware (GPUs/TPUs for training models; cloud computing resources), and new software frameworks (machine learning libraries, platforms). Widespread AI adoption requires integrating AI into existing IT systems and business processes, which is non-trivial (organisations need to invest in talent and change workflows). For advanced AI (like self-driving cars or robotics), physical infrastructure like sensors, high-speed networks, and reliable hardware is needed. Also important:	**Automat Cognitive** core econ is that it c intellectua scale and marginal **turns kno work into intensive service**, r past auto for physic This can c increase p – e.g., AI a can hand customer freeing hu complex t effectively **multiplyi workforc effective** also impr decision c analyzing data than could (bet prediction personali recomme etc.). It is spawn co **innovatio new prod** as electric electric ap AI will lea "intelligen in virtually everythin homes, sn etc.). Qua projection striking: a economis

GPT	Medium of Transformation	Domains Transformed	Adoption Curve	Initial Skepticism / Dismissal	Infrastructure Requirements	Core Ecor Leverage
			detectable productivity boost could appear within this decade – possibly in just *7 years* from the breakthrough moment [30] [31] (faster than the ~15 years it took computers/ Internet). We are likely on the steep part of the adoption curve for AI, with rapid growth in enterprise and consumer use expected in the 2020s.	concerns. Additionally, concerns about job displacement create resistance ("AI will take our jobs" leading some to hope it fails). Nevertheless, as AI systems continue to improve and demonstrate value (sometimes superhuman performance in fields like chess, Go, coding), the skepticism is diminishing. The pattern echoes prior GPTs – early doubt, then gradual acceptance as the tech matures.	regulatory frameworks and ethical guidelines, given AI's broad societal impact. In short, making AI a general utility involves computing infrastructure at scale (akin to a "cognitive grid") and retooling industries to effectively use AI outputs.	consultan suggest A raise glob productiv substantia scenario s boosting productiv over 20 ye baseline Unlike pre AI might i show up a "productiv paradox" investmen immediat growth) once com innovatio reorganiz catch up, potential *the interne* For instan estimate t generativ add **more** GDP grow introducti web did the long r offers **ma** **reductior** **predictio** **cognitior** scale, whi unlock a r economic and huma capability placing it territory.

(Note: Adoption times are indicative; "years from innovation to productivity" bars for these GPTs have shrunk: ~60 years for steam, ~30 for electricity, ~15 for Internet/IT, and perhaps <10 for AI [30] [31].)

AI vs. Traditional Software

A critical distinction to understand is how Artificial Intelligence differs from traditional software engineering – this underscores why AI should be seen not just as an application, but as a *cognitive substrate* underpinning many applications. In traditional programming, a human developer anticipates scenarios and writes explicit instructions (algorithms) for the computer to follow. The program's behavior is fully determined by this human-crafted logic. This is powerful for well-defined tasks (e.g. calculating payroll, sorting a list) but **inflexible** outside its prescribed domain – the software cannot handle cases it wasn't explicitly coded for. Maintaining such software at scale is also labor-intensive, as new features or edge cases require more lines of code.

AI-based systems, especially those using machine learning, **invert the development process**: the developer provides a general model structure and training data, and the *system autonomously "writes" its own rules* by learning from examples. The result is a model that can capture subtleties and correlations that programmers might not even be aware of. For instance, instead of trying to code rules for recognizing handwritten digits (a nearly impossible job due to the variability of handwriting), engineers feed a deep learning model thousands of sample images of digits, and the AI learns to recognize patterns of strokes and shapes that correspond to each number. This learned model can then correctly classify new, unseen handwriting with high accuracy – a feat that would be prohibitively complex to achieve through manual coding. **The ability to learn from data means AI software can adapt to new inputs** and even improve over time with more data, whereas traditional software stagnates without human intervention.

Another way to frame it: traditional software is like a rigid tool, whereas AI is more like a **flexible, trainable brain** that can be taught different tasks. This is why AI is often described as a platform or substrate – you can take a general AI model and fine-tune it to perform a variety of functions (the same large language model can be adapted to write code, compose music, or answer medical questions, depending on the training it's given). In contrast, an accounting software can't morph into a medical diagnosis tool without completely different code being written from scratch. AI, especially modern foundation models, provides a *general cognitive capability* that developers can harness across applications, much like electricity provides a general power source that appliance makers plug into.

A concrete example of the AI vs. code difference is in autonomous vehicles: Traditional robotics approached self-driving by hard-coding rules ("if obstacle ahead, then brake"), but the real world has infinite "ifs" that programmers can't enumerate [38] [39]. AI changed the approach to **learning a driving policy from experience** – basically having the AI observe human drivers and learn to predict what a human would do in various situations [39] [40]. The AI system internally develops a complex model to mimic good driving behavior, which ends up handling scenarios far beyond what any programmer could explicitly anticipate. This learned policy can generalize to new roads or unexpected events better than any static program of rules. The success of this approach (used by companies building self-driving cars) highlights how AI serves as a *cognitive engine*, not a static program.

Furthermore, **AI operates on probabilistic principles**, allowing for graded confidence and handling of uncertainty. Traditional software is usually deterministic – given input X, it produces output Y exactly as coded. But many real-world problems are inherently uncertain (e.g. "Is this email spam?" has no 100%

correct algorithmic answer without context). AI systems output probabilities or confidence levels (e.g. "90% spam") and can be designed to improve as they encounter edge cases (online learning). This is more akin to human reasoning and is why AI can tackle problems like speech recognition or medical diagnosis where answers aren't black-and-white. Traditional software in these domains was brittle; AI is **robust in the wild** because it learned from noisy, complex real-world data.

Because of all these differences, AI truly functions as a **cognitive layer** in technology stacks. Instead of viewing AI as just another program, businesses are beginning to view it as an asset that *empowers other programs and people*. For example, an e-commerce platform might integrate an AI recommendation engine – the AI isn't a standalone product, it's an embedded intelligence that makes the entire platform more effective by personalizing the user experience. This is analogous to how electrical wiring is built into almost every physical product or system (from kitchen appliances to factory robots) to provide power – now AI is being built into products and systems to provide *intelligence*. It's present in your phone, your car, your bank's fraud detection system, the factory producing your goods, and so on.

The implication is that AI should be managed and invested in not as a narrow IT project but as **infrastructure**. Forward-thinking organizations treat AI models and data as strategic infrastructure – much like having electricity or internet connectivity is essential for operations, having AI capabilities (and the data to fuel them) will be essential for competitive performance. AI's role as a substrate is also evident in how it can enable other innovations: for instance, AI can accelerate scientific R&D by sifting through research data (some call AI an "invention of a method of invention" [34] [35]). In software development, AI code generators can handle routine programming tasks, effectively becoming a layer that augments human developers.

In summary, **traditional software is a set of explicitly defined tools, whereas AI is an adaptive, general problem-solver**. AI is *software that creates software*, in a sense – it finds its own solutions. This makes it a fundamentally different kind of technological resource. It invites comparisons to utilities: one wouldn't call electricity or the internet just "another appliance"; they are enabling layers. Likewise, AI isn't just another app – it's a layer of *artificial cognition* that many or most future apps and machines will leverage. This is why AI is rightly viewed as a general-purpose technology with a transformative role akin to that of electricity. As Microsoft's CEO Satya Nadella put it, "AI is the runtime that is going to shape all of the software going forward" – meaning it will underlie and shape essentially all applications, rather than being isolated to one use-case. Organizations and society at large will benefit by recognizing AI as this pervasive cognitive infrastructure and adapting accordingly (through skills training, ethical frameworks, and strategic deployment across sectors).

Economic and Social Implications

History shows that General Purpose Technologies often bring about great economic gains, but usually with a lag as complementary innovations and adaptations occur. Each of our four GPTs eventually delivered significant productivity improvements and societal changes, albeit on different timelines and scales. By examining these, we can frame AI's current and potential future impact.

Steam's Impact: Steam power drove the Industrial Revolution, but measured productivity gains from steam took decades to materialize. Early on, steam engines were a small share of the capital stock and not very efficient, so their contribution to growth was modest. Economic historians have quantified this: in Britain, steam technology's direct contribution to annual productivity growth in the early 1800s was under 0.1% per year – almost imperceptible at the macro level [22] [41]. It wasn't until the mid-19th century, when highpressure engines and railways became widespread, that steam's impact peaked. Even then, one comprehensive estimate finds the **total steam-driven productivity boost in Britain** averaged only about 0.2–0.3 percentage points of extra labor productivity growth at its height [24] [25]. To put that in perspective, that is smaller than the later boost from electricity or ICT. Why relatively low? Partly because diffusion was still incomplete and many complementary practices (like reorganization of factories for steam or skills to maintain engines) were still catching up. However, steam's value should not be understated: it provided the backbone for industrialization, enabling the **mass production and modern economic growth** that lifted GDP per capita in industrializing nations. By the late 1800s, steam railroads and ships had dramatically lowered transportation costs (often cited as "social savings"), facilitating national markets and trade [42] [43]. Socially, steam power urbanized societies (factories drew workers to cities) and changed daily life (railroads even standardized timekeeping). It also had darker facets: it increased demand for coal mining (with environmental and labor implications) and enabled imperialism via steamships and railroads. In sum, steam's implication was the **birth of the modern industrial economy**, with perhaps slower productivity payoffs than one might assume from its revolutionary status, but a profound reordering of society and work.

Electrification's Impact: Electricity is often credited with powering the rapid economic growth of the early 20th century, especially in the United States and Western Europe. Unlike steam, electricity's productivity benefits showed up more quickly once the technology matured. By the 1920s, the U.S. saw what's sometimes called the "second industrial revolution productivity boom." Data confirm that **TFP (total factor productivity) and labor productivity growth nearly doubled in the 1920s** compared to the previous two decades [17] [27]. A major driver was the widespread adoption of electric motors and the resulting factory floor transformations. One influential study by economist Paul David showed that initially (1890s), factories just replacing steam engines with electric motors didn't see big gains – it was only after about 25-30 years, when factories were redesigned (with machine-specific motors, new layouts, etc.), that productivity surged. By 1929, **electric motors provided 78% of mechanical power in U.S. manufacturing (up from 10% in 1900)**, and productivity in manufacturing jumped accordingly [15]. Growth accounting analyses estimate that from 1899 to 1929, electrification raised U.S. labor productivity growth by about **0.5 percentage points per year** (a very sizable effect) [24] [25]. This means perhaps a quarter or more of the economic growth in that period can be attributed to electric-powered innovations (assembly lines, mass production of consumer durables, etc.). Socially, electricity had enormous implications: it led to the rise of consumer culture (radios, refrigerators, electric lights in homes – leisure time and quality of life improved). It also changed work: electric lighting and streetlights made cities safer and enabled nightlife; factories could operate in shifts around the clock. Electrification spread to rural areas more slowly (e.g. the Tennessee Valley Authority in the 1930s New Deal era brought power to many U.S. rural communities), but once it did, it boosted agricultural productivity (electric pumps, refrigeration, etc.) and rural living standards. By drastically reducing the cost of energy and enabling new inventions, electricity likely had the largest impact on raising living standards in the first half of the 20th century – some have called it the **"biggest engineering achievement of the 20th century."** From an innovation spawning perspective, electricity underpinned later technologies like electronics and computing (no electric power, no computers or internet). The initial skepticism about electricity was overcome by the clear advantages, and investment in electric infrastructure paid off in a big way, though often after a lag of a decade or two.

Internet/ICT's Impact: The introduction of computers and the internet in the late 20th century at first puzzled economists because of the **productivity paradox** articulated by Robert Solow in 1987: "You can see the computer age everywhere but in the productivity statistics." Indeed, in the 1970s and 1980s, despite computers spreading in offices and factories, overall productivity growth slowed (oil shocks and other factors contributed, but IT hadn't yet shown a big macro effect). This changed in the mid-1990s. The combination of personal computers, enterprise software, and internet connectivity reached a critical mass, and businesses learned how to leverage them (e.g. supply chain management systems, online sales platforms, etc.). The U.S. experienced a **productivity resurgence from about 1995 to 2004**, with labor productivity growth accelerating to ~3% per year (up from ~1.5% in prior years) [29]. Detailed analyses showed that industries that invested heavily in IT (like retail with Walmart's logistics or finance with algorithmic trading) saw outsized gains. A famous statistic: by the early 2000s, IT-producing and IT-using industries accounted for essentially all of the surge in productivity – meaning the rest of the economy, absent IT, was still growing slowly [44]. In essence, the internet and related ICT finally delivered the broad efficiency improvements (faster information flow, process automation, reduced downtime, etc.) that earlier generations anticipated. By one estimate, **the spread of ICT (including internet) contributed about 0.6–0.8 percentage points to U.S. productivity growth around 1995–2005** [24] [25], which is even larger than electricity's contribution in its heyday. After 2005, productivity slowed again in many countries – some argue this is because the low-hanging fruits of basic internet/IT were picked, and we await new GPT advancements (like AI) to spur another jump.

Beyond numbers, the internet's social impact has been transformational: globalization accelerated (companies could coordinate complex global supply chains in real-time; knowledge work could be offshored via connectivity). Communication became democratized – anyone with internet access could publish information (blogging, later social media) or learn from the world's information (search engines). This has had mixed effects: empowering individuals and small businesses, but also disrupting traditional media and raising issues of misinformation. Culturally, the internet changed how we socialize (with the rise of social networks, video conferencing, etc.), how we shop (e-commerce overtaking brick-and-mortar in many areas), and even how we find relationships (online dating). It's hard to find an aspect of life untouched. By connecting billions of people, the internet also created winner-take-most dynamics in business (the rise of tech giants) due to network effects and access to global user bases. In summary, the **internet delivered a powerful productivity boost and reshaped society into an information age**, though it took a couple of decades from the invention for the biggest effects to be realized. Interestingly, some analyses find that AI's potential impact might surpass that of the internet: for example, a JP Morgan analysis (drawing on work by economist Nick Crafts) estimated the internet (PCs/IT from 1980s) ultimately increased macro productivity by about 12.6%, whereas AI could eventually boost it by around 17.5% (if certain adoption scenarios play out) [32] [33].

Figure: Historical Pace of Technology Adoption (US Households) – Each successive major technology reached 90% adoption faster than the previous. For example, landline phones took ~70 years to go from 10% to 90% penetration, electricity ~50 years, mobile phones ~20 years, and the internet ~14 years. AI-driven services (like smartphone apps) are on an even faster trajectory, suggesting GPT diffusion rates have accelerated [45].

AI's Current and Projected Impact: AI is still in the early stages of diffusion, but signs of its transformative effect are already evident. At the firm level, studies show AI-adopting companies have begun to see higher productivity than non-adopters [46] [47]. For example, research finds significant productivity premiums for firms that invest in AI, often through improved product innovation and process efficiency [46] [47]. On the economy-wide level, we have yet to see a sharp uptick in productivity attributable to AI – and indeed, there is active debate about the "AI productivity paradox." It resembles earlier GPTs: heavy investments in AI and machine learning in the 2010s did not immediately translate to productivity growth in national statistics, perhaps because we're in the **investment/transition period**. Many tasks are being restructured around AI, data infrastructure is being built, and workers are learning to work alongside AI – these intangible investments might not show output gains until a little later [48] [34]. This concept is sometimes described as a J-curve: productivity may first dip or plateau as organizations retool for the new technology, then rise once complements are in place [49] [50].

That said, the rapid improvements in AI capability suggest the potential for a sizable economic impact. Large language models and generative AI (like GPT-4) introduced in 2022–2023 have demonstrated they can perform a wide range of tasks (from writing code to drafting legal documents) at a level that approaches or exceeds human ability in some instances. If effectively harnessed, this could dramatically increase white-collar productivity. For example, a McKinsey report in 2023 estimated that generative AI could add **$2.6 to $4.4 trillion in economic value annually** across industries by augmenting various knowledge work tasks (roughly 15-20% of global corporate profits) – akin to the kind of boost the internet gave, but concentrated in the next decade. The **marginal cost aspect** is critical: deploying an AI solution across millions of transactions or interactions costs very little compared to hiring and training equivalent humans for each instance. So we could see an era of "free cognitive labor" powering a lot of economic activity.

One quantitative projection (from the IMF, modified by JP Morgan analysts) assumed that about half of the tasks in jobs that are AI-susceptible will be automated over 20 years. Under that scenario, **AI would raise cumulative labor productivity by an extra ~17.5%** (above baseline growth) after two decades [32] [33]. That averages out to roughly 0.8 percentage points higher annual productivity growth, which is enormous – similar to the boost the earlier Industrial Revolutions eventually delivered, but potentially on a faster timeline. Another study by the OECD notes that current generative AI could significantly affect ~20% of jobs' tasks (meaning those tasks could be at least 50% automated) and moderately affect many others [51] [52]. This indicates a broad swath of the economy will need to adapt, much as virtually every manual occupation was touched by electrification or mechanization.

Of course, economic gain is only one dimension. **Social implications of AI** are equally profound. AI brings up concerns about job displacement: just as mechanization reduced the need for some manual labor (while creating new jobs in machine maintenance, etc.), AI might reduce demand for certain cognitive skills (data entry, routine analysis) but increase demand for others (AI oversight, engineering, creative work). There may be an adjustment period with labor market frictions. Historically, GPTs have often caused temporary widening of inequality – e.g., early industrialization benefited factory owners more than artisans, and IT tended to favor skilled workers over unskilled (skill-biased technical change). AI could similarly be skill-biased, benefiting those who can work with AI or who own the capital behind AI. Policymakers are already discussing how to upskill workers and possibly redistribute AI's gains (through education, social safety nets, maybe even ideas like universal basic income if automation becomes very widespread).

Another social aspect is **ethical and regulatory**: previous GPTs had safety and policy challenges (steam engines and railroads needed safety regulations; electricity required building codes and utility regulations; the internet spawned data privacy and cybersecurity laws). AI is prompting discussions around algorithmic bias, transparency, and accountability. Governments and international bodies are working on AI governance to ensure it's used responsibly (e.g., not entrenching biases or enabling unlawful surveillance). This is similar to how earlier GPTs eventually led to new institutions (for instance, labor laws in the industrial age, or antitrust in the era of electrified industries and later IT monopolies).

Finally, AI has the potential to **spawn entirely new innovations and even paradigms** that we can't fully predict – akin to how electricity led to things like radio and computing, and the internet led to social media and mobile apps. For example, AI could accelerate scientific research ("AI for Science"), leading to breakthroughs in drug discovery or climate modeling more quickly [53]. It could also give rise to new forms of art and entertainment (AI-generated content as a medium). On the flip side, risks such as autonomous weapons or advanced AI systems that humans struggle to control are also being flagged; these were not concerns with past GPTs, so society may need novel risk mitigation strategies.

In summary, the economic and social implications of AI, while still unfolding, position it firmly as a GPT with a transformative impact. If history is a guide, we are in the early diffusion phase: productivity statistics may not yet fully reflect AI's potential, skepticism and disruption coexist with enthusiasm, and complementary investments (in skills, infrastructure, regulation) are in progress. But given AI's rapid improvement and broad applicability, many economists and technologists argue we are on the cusp of another major step-change in productivity and economic growth [36] [54] – one that could rival the introduction of electricity or the internet in its breadth. Societally, AI might bring about as dramatic a change to work and daily life in the 21st century as steam power did in the 19th. The challenge and opportunity now lie in guiding this technology to maximize broad benefits (augmenting human capabilities, solving pressing problems) while managing the transition pains and ethical dilemmas that accompany any powerful new technology.

Conclusion

Drawing together the threads of this analysis, it's evident that Artificial Intelligence exhibits all the hallmark characteristics of a General Purpose Technology. It is becoming **pervasive**, with AI systems diffusing into virtually every industry and even into consumer devices in our homes and pockets. It is undergoing **continuous rapid improvement** – the past decade has seen step-change advancements in AI capabilities (from image recognition surpassing human accuracy to AI models passing professional exams), with no sign of slowing as research and investment intensify. And it is **spawning innovations** left and right: new AI-driven startups, novel applications (like AI in education for personalized tutoring, AI in healthcare for drug discovery), and even new research methodologies in the sciences. In these respects, AI stands in the same league as steam, electricity, and the internet when they began to reshape the world.

Crucially, our comparative look at earlier GPTs offers some insight into AI's trajectory. Just as those technologies did not transform society overnight but did so surely over a period of years or decades, AI's impact is likely to follow an S-curve: we are possibly in the earlier stages of that curve. **We are beginning to see the inflection point** – public awareness of AI's power surged in 2023 with generative AI, businesses are rapidly experimenting with AI integration, and governments are formulating AI strategies. If the pattern holds, the late 2020s and 2030s could be the time when AI's contributions to productivity and economic growth become clearly visible in the data (perhaps mirroring how the 1920s were electricity's boom and the late 1990s were the internet's). Indeed, optimists argue that we might already be accelerating into a new productivity era powered by AI, potentially pulling us out of the stagnation that followed the last IT boom [30] [31].

Viewing AI as a **cognitive substrate** rather than just an application is more than an analogy – it's a practical perspective that influences how we prepare for the future. Just as industries that recognized electricity's ubiquitous potential adapted and thrived (while those that ignored it fell behind), organizations and societies that recognize AI as foundational will invest in the necessary complements: data infrastructure, AI skills in the workforce, and processes redesigned to leverage AI's strengths. AI is not simply another tool in the toolbox; it's akin to a new form of industrial power or a nervous system that can be woven into operations. This report has drawn parallels with past GPTs to emphasize that point. In electricity's early days, some viewed it merely as "electric light" – a neat gadget. Only later did people realize it could power any machine and revolutionize production. Similarly, today one might view AI as just “chatbots” or predictive algorithms in isolation, but in time we’ll see it permeate all tools, making them smarter and more autonomous.

Where are we on the curve? Likely at a juncture analogous to the internet in the early/mid-1990s or electricity in the 1900s. The core technology exists and is proven, visionary uses are emerging, and investment is pouring in, but the full impact (the “plateau” of the S-curve) lies ahead. There is work to do to reach that plateau: policy frameworks to ensure AI is used ethically and inclusively, educational efforts to equip people with AI-augmented skills, and international cooperation to manage risks (just as railways needed standardized gauges and signaling, AI might need global standards and safeguards). The historical comparison also reminds us that **transformation comes with disruption** – jobs will change, business models will be overturned, and those who adapt will prosper while others may struggle. Society will need to navigate these challenges, learning from how earlier generations handled the upheavals of mechanization or digitization.

In conclusion, AI’s capabilities and the breadth of its influence to date put it firmly in GPT territory. It is on a path to reshape economies and societies as profoundly as steam power did in the 19th century, electricity in the 20th, and the internet in the 21st. Each of those technologies unlocked new frontiers: steam freed us from muscle power and set industrialization in motion; electricity brought convenient energy that spurred mass innovation and raised living standards; the internet collapsed communication distances and unleashed the information age. **AI’s frontier is the automation and enhancement of cognition itself** – a transformative development not just in economic terms but in what human beings can achieve. As AI continues to evolve, we can expect waves of change: some we can predict (efficiency gains, new products, better services) and others we can only imagine (perhaps entirely new industries or ways of organizing society enabled by AI).

What is clear from this comparative analysis is that treating AI as a general-purpose, enabling technology – and not simply a piece of software – is key to fully realizing its benefits. History teaches us that those who embraced the general-purpose nature of past GPTs reaped enormous rewards. If we do the same with AI, pairing its deployment with thoughtful innovation in business models, education, and policy, we stand to enter a new era of growth and societal advancement. In that sense, AI is not just following the GPT playbook; it is extending it – potentially driving progress at a pace and scale that will be remembered as a defining feature of our time. The steam engine powered the **Industrial Age**, electricity powered the **Machine Age**, the internet powered the **Information Age**, and now AI may well power a new **Intelligence Age** – a chapter still in its opening pages, with many more transformations still to come.

Sources:

1. Bresnahan, T. & Trajtenberg, M. (1996). *General Purpose Technologies: Engines of Growth?* – **defined three criteria of GPTs** [1] .

2. Rijo, L. (2025). “Generative AI shows characteristics of GPT” – *OECD analysis on generative AI’s pervasiveness, improvement, and innovation spawning* [34] .

3. Jovanovic, B. & Rousseau, P. (2005). *General Purpose Technologies* – **economic history of GPT diffusion and lags** [55] .

4. Rosenberg, N. & Trajtenberg, M. (2004). *The Corliss Steam Engine…* – **steam engine as Industrial Revolution GPT** [8].

5. Wilde, R. (2025). “Steam in the Industrial Revolution” – *historical overview of steam power’s applications* [4] and slow adoption factors [5].

6. Devine, W. (1983). *From Shafts to Wires: Historical Perspective on Electrification* – **describes transition from steam to electric power in factories** [14].

7. Post, T. (2022). “AI is the New Electricity” – *discusses electrification’s impact and parallels to AI adoption* [10] [11] [12].

8. Stackpole, B. (2024). *MIT Sloan: Generative AI as a GPT* – **notes experts see AI as game-changing GPT with faster diffusion** [3] [37].

9. Snopes (2018). *Paul Krugman internet quote fact-check* – **Krugman’s 1998 dismissal of internet’s impact** [28].

10. Crafts, N. (2021). *Oxford Review of Economic Policy:* – **quantifies steam vs electricity vs ICT productivity contributions** [24] [25].

11. J.P. Morgan Private Bank (2024). “How AI can boost productivity and jump start growth” – **charts on GPT adoption lags and productivity upside (Crafts’ data)** [30] [31] [32].

12. U.S. Bureau of Labor Statistics & BEA data (various) – *productivity growth rates in 1920s, late 1990s* [17] [29].

13. McKinsey (2018). “The economics of artificial intelligence” (interview with Ajay Agrawal) – **AI lowers cost of prediction, analogous to past GPT cost reductions** [20] [21].

14. Marcus, G. & Davis, E. (2019). *Rebooting AI – critiques of AI’s limitations (“stochastic parrot” arguments)* (not directly cited above but provides context on skepticism).

15. Our World in Data – *Technology adoption timelines* – **visualization of accelerating adoption rates for major technologies** [45].

(Additional citations are embedded in-text as per the format. All sources are publicly available research papers, historical economic data, and reputable tech/economics articles.)

---

[1] [7] [55] doi:10.1016/S1574-0684(05)01018-X
https://dl.icdst.org/pdfs/files/21c2154fdfc94b8dec0c8a903b27e167.pdf

[2] [49] [50] General-purpose technology - Wikipedia
https://en.wikipedia.org/wiki/General-purpose_technology

3 36 37 46 The impact of generative AI as a general-purpose technology | MIT Sloan
https://mitsloan.mit.edu/ideas-made-to-matter/impact-generative-ai-a-general-purpose-technology

4 5 6 Steam Engines and the Industrial Revolution
https://www.thoughtco.com/steam-in-the-industrial-revolution-1221643

8 A General-Purpose Technology at Work: The Corliss Steam Engine in the Late-Nineteenth-Century United States | The Journal of Economic History | Cambridge Core
https://www.cambridge.org/core/journals/journal-of-economic-history/article/abs/generalpurpose-technology-at-work-the-corliss-steam-engine-in-the-latenineteenthcentury-united-states/105A54480CA78DC54D49D596061B5FE4

9 Artificial Gas and Electrical Lighting Systems Are Developed That ...
https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/artificial-gas-and-electrical-lighting-systems-are-developed-change-living-and-work-patterns

10 11 12 13 19 26 AI is the New Electricity. Whole eras of technological progress… | by Tristan Post | AI Strategy Institute | Medium
https://medium.com/ai-strategy-institute/ai-is-the-new-electricity-3f48d9a9f2d6

14 From Shafts to Wires: Historical Perspective on Electrification | The Journal of Economic History | Cambridge Core
https://www.cambridge.org/core/journals/journal-of-economic-history/article/abs/from-shafts-to-wires-historical-perspective-on-electrification/500078D9B4764BA1109A7967437CF226

15 The U.S. Economy in the 1920s – EH.net
https://eh.net/encyclopedia/the-u-s-economy-in-the-1920s/

16 28 Did Paul Krugman Say the Internet's Effect on the World Economy Would Be 'No Greater Than the Fax Machine's'? | Snopes.com
https://www.snopes.com/fact-check/paul-krugman-internets-effect-economy/

17 18 27 [PDF] Total Factor Productivity Growth in Historical Perspective
https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/workingpaper/44002_TFP_Growth_03-18-2013_1.pdf

20 21 38 39 40 The economics of artificial intelligence | McKinsey
https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-economics-of-artificial-intelligence

22 23 41 42 43 wp7503
https://www.lse.ac.uk/Economic-History/Assets/Documents/Research/LSTC/wp7503.pdf

24 25 PRODUCTIVITY GROWTH IN THE INDUSTRIAL REVOLUTION:
https://www.frbsf.org/wp-content/uploads/crafts.pdf

29 The Growth of U.S. Factor Productivity - jstor
https://www.jstor.org/stable/2120561

30 31 32 33 54 How AI can boost productivity and jump start growth | J.P. Morgan Private Bank U.S.
https://privatebank.jpmorgan.com/nam/en/insights/markets-and-investing/ideas-and-insights/how-ai-can-boost-productivity-and-jump-start-growth

34 35 48 51 52 53 Generative AI shows characteristics of general-purpose technology
https://ppc.land/generative-ai-shows-characteristics-of-general-purpose-technology/

44 AI and Productivity Growth: Evidence from Previous Technologies
https://www.stlouisfed.org/on-the-economy/2024/apr/ai-productivity-growth-evidence-historical-development-other-technologies

[45] Price over performance: Why green energy is different from previous technology revolutions | Utility Dive
https://www.utilitydive.com/news/price-over-performance-green-energy-renewables-revolution/693115/

[47] Artificial intelligence as a general-purpose technology: an historical ...
https://academic.oup.com/oxrep/article/37/3/521/6374675