Peak Infrastructure

Why we need to balance building new infrastructure against better using existing infrastructure, to maximise the social and economic value from our investments | Ashley Barratt, Joe Inniss, and team

Introduction

Infrastructure networks such as transport, water, energy, and telecommunications have long been drivers of economic growth and development[i]. However, in recent decades some have suggested that developed nations are approaching "peak infrastructure"[ii], a maximal useful stock where continued expansion provides diminishing returns and poses sustainability challenges.

With infrastructure construction consuming substantial raw materials and emitting 23% of energy-related greenhouse gases[iii], additional development threatens carbon reduction goals. Meanwhile, smart technology and demand management offer potential to optimise existing assets.

We examine the emerging concept of peak infrastructure, considering both the sustainability risks of continued expansion as well as opportunities to better utilise current networks.

While developed regions appear close to useful infrastructure saturation, developing nations still require investment to meet basic social and economic needs and enable low-carbon growth. This will require collaborative policy and planning, including representation from across society and industry, specific to each local context.

The next two decades of infrastructure decisions are pivotal to either locking in emissions or enabling decarbonised, compact and liveable urban development patterns.

Diminishing Returns of new Infrastructure

The usefulness of new infrastructure follows an S-curve[i], with initial investments providing basic connectivity and middle investments enabling economic integration. At high levels of infrastructure stock, additional networks often serve redundant roles or encourage additional resource use. For example, highway expansions generally induce more vehicle travel rather than relieving congestion[iv]. Productivity gains flatten out once major transport and transmission routes are established.

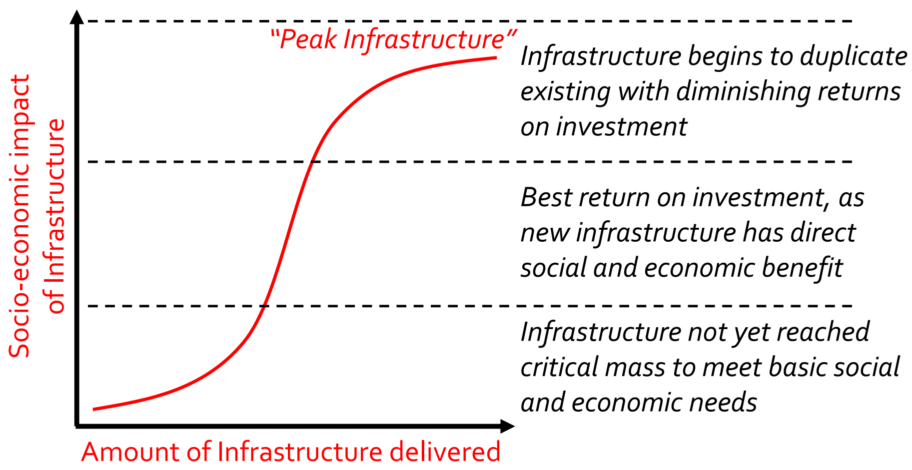
Developed regions with mature infrastructure have likely reached the flattening portion of the S-curve. The United States has over 4 million miles of roadways, the most extensive system in the world. Yet congestion has worsened over decades of expansion near major urban areas. Further airport growth provides limited time savings given security processing constraints[v]. And fossil fuel power plants now compete with cheaper renewables and flexible demand management.

Infrastructure to population ratios and accessibility metrics suggest saturation in portions of North America, Europe, and East Asia[i]: The U.S. has 5.3 square meters of paved roadway per person compared to only 0.5 in India[vi], indicating ample transport networks for current needs. While particular links and facilities require ongoing renewal, major new highways or airports bring high financial and environmental costs with declining marginal returns.

Many developed nations are stuck in an investment culture: instinctive investment behaviours based on historically successful strategies, where the answer to all asset capacity utilisation questions was to build more infrastructure.

Sustainability Challenges

Infrastructure is resource intensive, with cement manufacturing alone generating 8% of global carbon dioxide emissions[vii]. Construction and demolition debris accounts for over 35% of solid waste[viii]. The operation of networked systems, consumes huge quantities of energy and water.



Further, infrastructure choices shape development patterns with long-term emissions consequences. Car-centric transport enables sprawling suburban growth, locking in car dependence[ix]. Rigid transmission grids discourage distributed renewable generation[x]. And fossil fuel assets constrain transition away from carbon-intensive energy.

With developed regions already having sizable environmental footprints, additional concrete-and-steel infrastructure threatens sustainability aims. However, declining investment also poses risks of deteriorating service, undersupply, and system failures. Balancing maintenance with selective system expansion remains an art. But ritualistic additions of new infrastructure should not be reflexive.

Opportunities for Optimisation

If developed countries have neared peak useful infrastructure, the focus must turn to optimisation of existing assets rather than proliferation. Fortunately, maturing systems present various optimisation opportunities.

Firstly, good asset management: prioritising maintenance, strategic upgrades, and incremental additions can bolster performance at relatively low cost, countering notions of inevitable decline beyond peak supply[xi]. Institutional capacity for life-cycle asset management is crucial.

Second, advanced metering, monitoring and control technology enables better utilisation of current infrastructure. Examples include intelligent transportation systems, smart grids, and digital water network management[xii].

Combining physical and digital infrastructure layers can help to unlock additional productivity.

Urban redevelopment and densification also offer potential, concentrating population in transit-served nodes encourages greener, more efficient means of transport, as infrastructure sees more intensive use[xiii] and integrating land use with transport planning enables feasible alternatives to car-centric mobility[xiv].

Balancing Underinvestment Risk

Avoiding new emissions-intensive infrastructure has appeal. But delayed system renewal and deficient capacity also carry economic, social and environmental costs. Congestion from constrained mobility generates excess emissions. Failures and service disruptions undermine household access and business continuity. Extending the lifespan of old inefficient assets locks in carbon production, from leaky pipes to coal power.

Cities without adequate housing, transport, greenspace, and social services become less liveable, equitable and environmentally resilient[xv]. Weak connectivity hampers urban economic productivity and competitiveness. Avoiding underinvestment requires nuance, not blanket prohibition. Particularly for green infrastructure like public transit, EV charging, district thermal networks, and renewable power, selective expansion aligns with climate objectives. Denser settlement patterns enable low-carbon lifestyles. Getting incentives, planning frameworks, appraisal tools and financing right to encourage sustainability-enhancing projects remains a key challenge[xii].

The Local Context

Peak infrastructure thus presents both opportunities and risks. Developed regions must actively optimise, adapt and maintain existing assets rather than pursue business-as-usual expansion. But targeted, sustainability motivated investment will still be warranted. Renewal and redevelopment should improve liveability amidst constraints.

Developing countries though have pressing infrastructure needs for basic access, economic integration and urbanisation[i]. Building sustainably will require upfront financing. However, latecomer advantage enables leapfrogging carbon-intensive stages of development. Planning must integrate infrastructure provision with rapid growth at affordable densities.

Neither blanket expansion nor prohibition are wise paths forward. Instead, policymakers and planners must find a way forward aligned to local context and sustainable social and economic objectives. Incentives and appraisal tools geared toward climate goals are crucial. Sophisticated modelling can help assess economic, social and environmental trade-offs. With collaboration and commitment, peak infrastructure may act not as a hard constraint but an inflection point for more creative, optimised and greener infrastructure systems.

Conclusion

Evidence suggests developed nations have reached peak useful infrastructure. Continued expansion threatens sustainability aims while providing diminishing returns. Yet undersupply poses its own risks. Asset optimisation, redevelopment and selective system expansion must be pursued.

Meanwhile developing countries require focused investment in sustainable infrastructure to meet development goals. The 2020s will prove pivotal in determining whether maximal infrastructure bends development along sustainable lines. With proper policy signals, collaboration and financing, peak infrastructure can spur innovation, not stagnation.

TL:DR

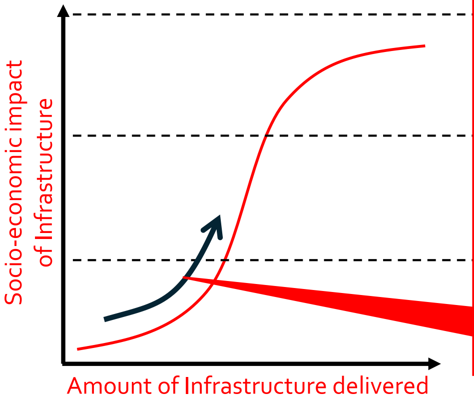
1. Infrastructure is good.

2. Developed nations have most of the infrastructure they need already.

3. Developed nations need to pivot from building new infrastructure to using and maintaining existing infrastructure better.

4. Developing nations should prioritise building infrastructure which maximises social and economic impact whilst minimising environmental costs.

What "Peak Infrastructure" means for developing nations:



*The priority for **developing nations** is in prioritising investment to reach a critical mass that meets basic social and economic needs as quickly as possible, serving as a foundation for future investment.*
All whilst minimising social and environmental costs associated with these projects, and taking advantage of knowledge and technology achieved from previous infrastructure development around the world

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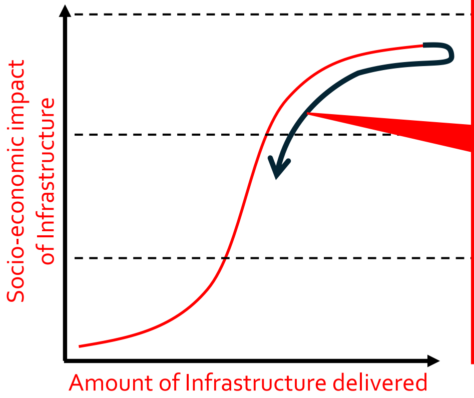

*The priority for **developed nations** is in investing in optimisation of existing infrastructure rather than building new infrastructure that duplicates that of existing infrastructure, whilst identifying new infrastructure technologies that provide better social and economic return on investments.*

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