



AN INTEGRATIVE BUSINESS MODEL FOR NET ZERO ENERGY DISTRICTS

INSIGHT BRIEF

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|||||| HIGHLIGHTS

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- **Net zero energy developments can be life-cycle cost neutral** compared to business as usual and have lower first costs to parcel developers, all while creating communities that are more livable, healthy, comfortable, resilient, and environmentally sustainable.
- **Rocky Mountain Institute has developed a business model** for developing net zero energy or ultralow energy districts in a way that is attractive to the district developer, parcel developer, and tenants; creates a profitable business for an integrated energy services provider; and benefits the local electric grid and neighboring community.
- With a holistic viewpoint, **district-scale developments are uniquely positioned to be a major driver** of the next generation of high-performance buildings and an intelligent electric grid, and to benefit financially from such leadership.

|||||| INTRODUCTION

Rocky Mountain Institute has developed an integrative business model for developing net zero energy (NZE) or ultralow energy districts in a way that is attractive to the district developer, parcel developer, and tenants, as well as beneficial to the local electric grid and neighboring community. While many elements are broadly replicable, this business case was first modeled specifically for the developer of a proposed 180-acre, 6 million ft², mixed-use NZE development located on a former industrial site in a midsize U.S. city.

In this paper we are using the term net-zero energy to describe the general concept where the energy consumption of a building or multiple buildings is offset by renewable energy on an annual basis and should not be taken as implying alignment to any one specific, more granular, definition.

CHALLENGE:

- **Master developers** of NZE districts face the challenge of **driving exceptional energy performance** without deterring prospective parcel developers or incurring exorbitant development costs themselves.
- Prospective parcel **developers may fear** that stringent performance requirements will require **higher upfront capital costs** or that achieving ultralow energy buildings **will not be cost-effective** in the long run, compared to business as usual.
- Prospective **tenants** of NZE developments may **fear** that **additional construction costs** will **get passed through to them** in the form of **higher rents**, or that the ongoing cost of procuring renewable energy may be **higher** than conventional **energy bills**.

SOLUTION:

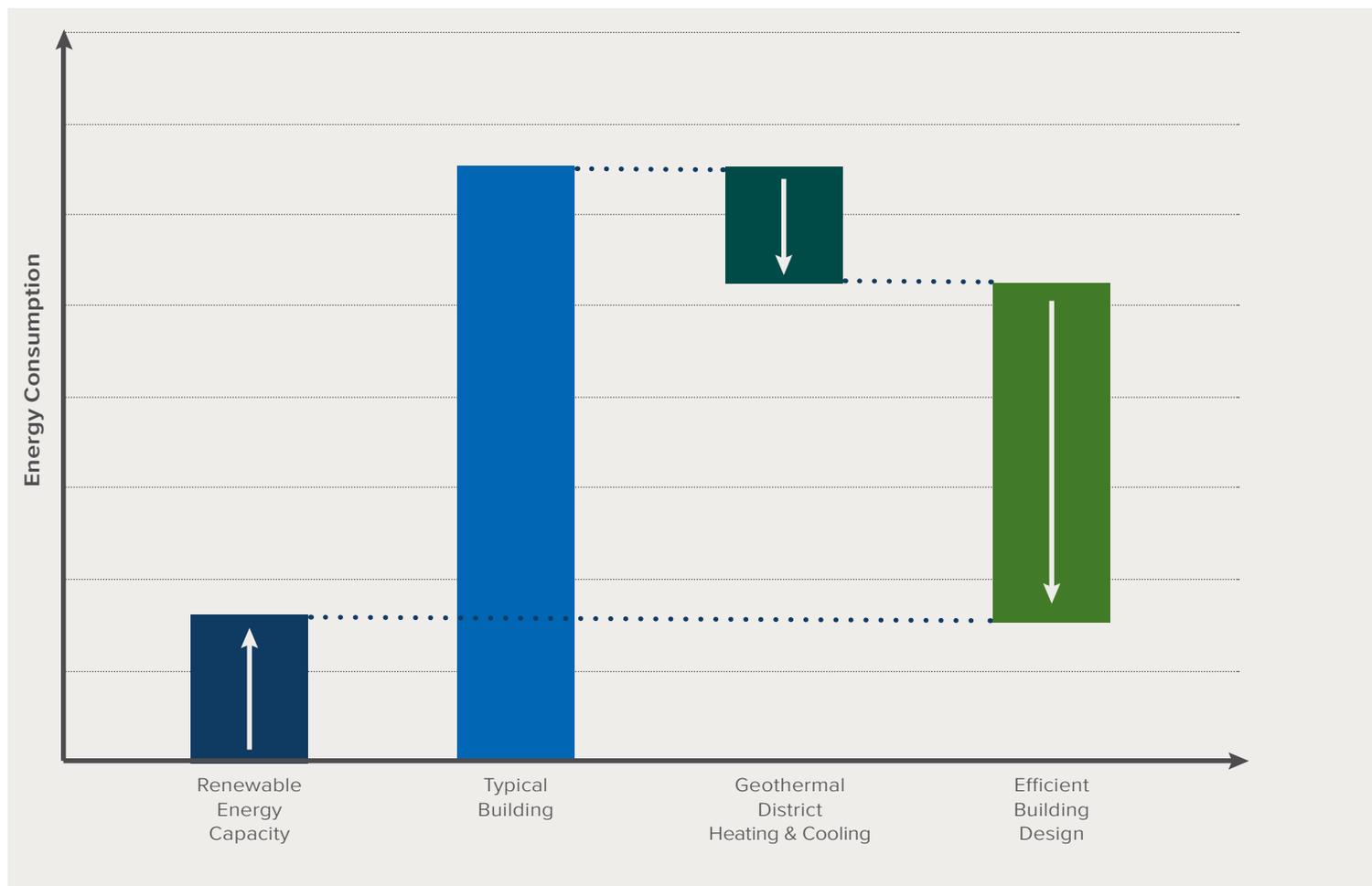
As this insight brief describes, executing NZE at the district scale in fact represents a huge opportunity. Districts have specific opportunities and advantages that individual buildings do not, helping overcome any such (real or perceived) concerns. The resulting NZE development is life-cycle cost neutral or better compared to business as usual and has lower first costs to parcel developers, all while creating a community that is more livable, healthy, comfortable, resilient, and environmentally sustainable.

||||| QUADRUPLE BOTTOM LINE**1: NET ZERO ENERGY**

Net zero energy is achieved in four steps:

1. Identify on-site renewable energy capacity and thus set the district's energy "budget"
2. Use superefficient district geothermal heating and cooling
3. Set design standards to drive down load significantly (up to 75 percent below code)
4. Iterate between steps 1 and 3 to optimize based on the net present value of the life-cycle cost until net zero energy is achieved

Figure 1: The Path to Net Zero Energy



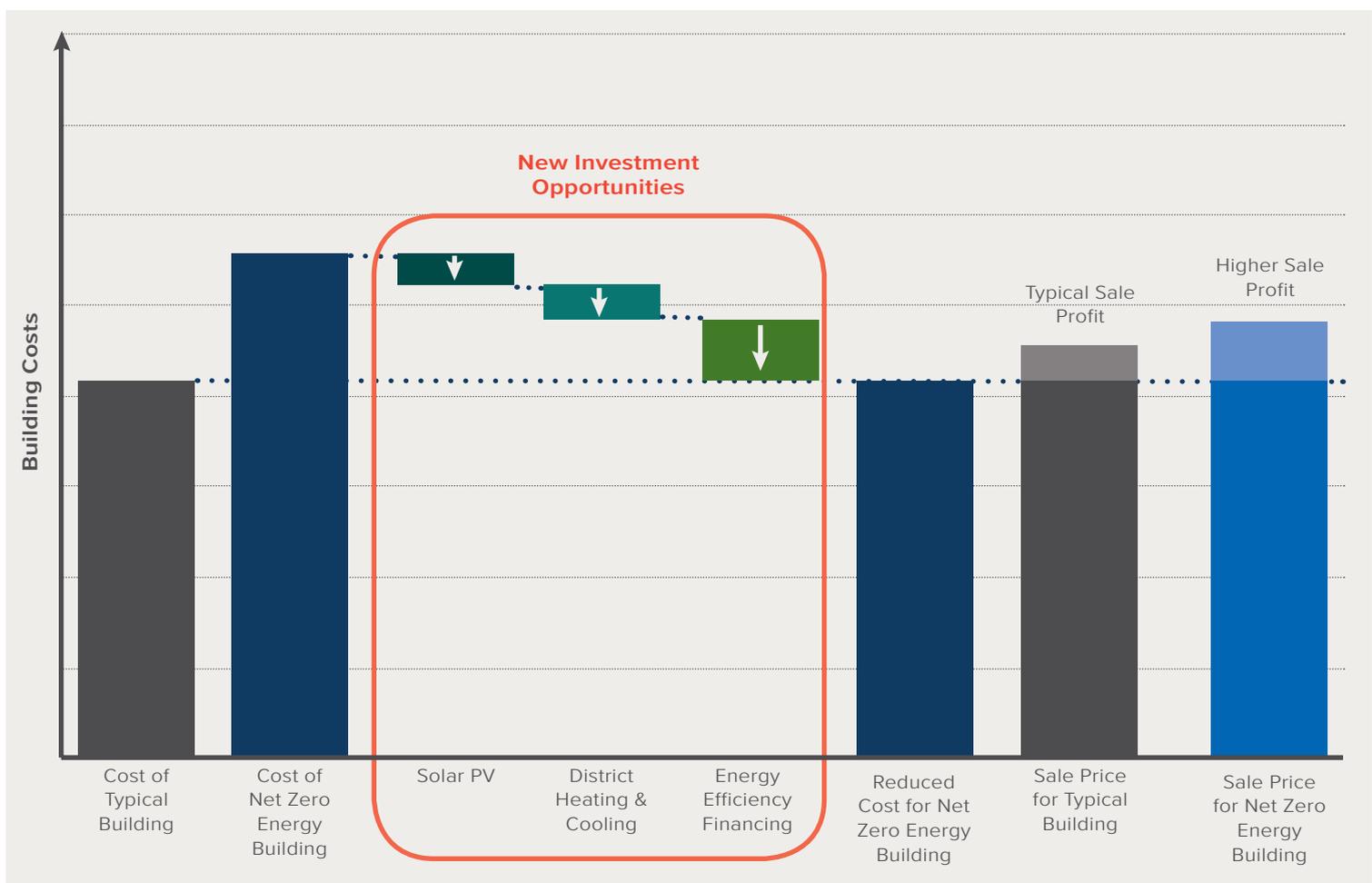
2: PARCEL DEVELOPERS

Make net zero energy **financially attractive to parcel developers** in three steps:

1. Establish third-party development and ownership of on-site solar photovoltaics (PV)
2. Move the capital cost of heating and cooling equipment out of buildings and into a district heating/cooling system
3. Provide on-bill financing for the incremental cost of energy efficiency. This puts first costs at or below the cost of a business-as-usual (BAU) building

On top of that, high-performance buildings typically yield higher sale prices or rents.

Figure 2: Financially Attractive to Developers



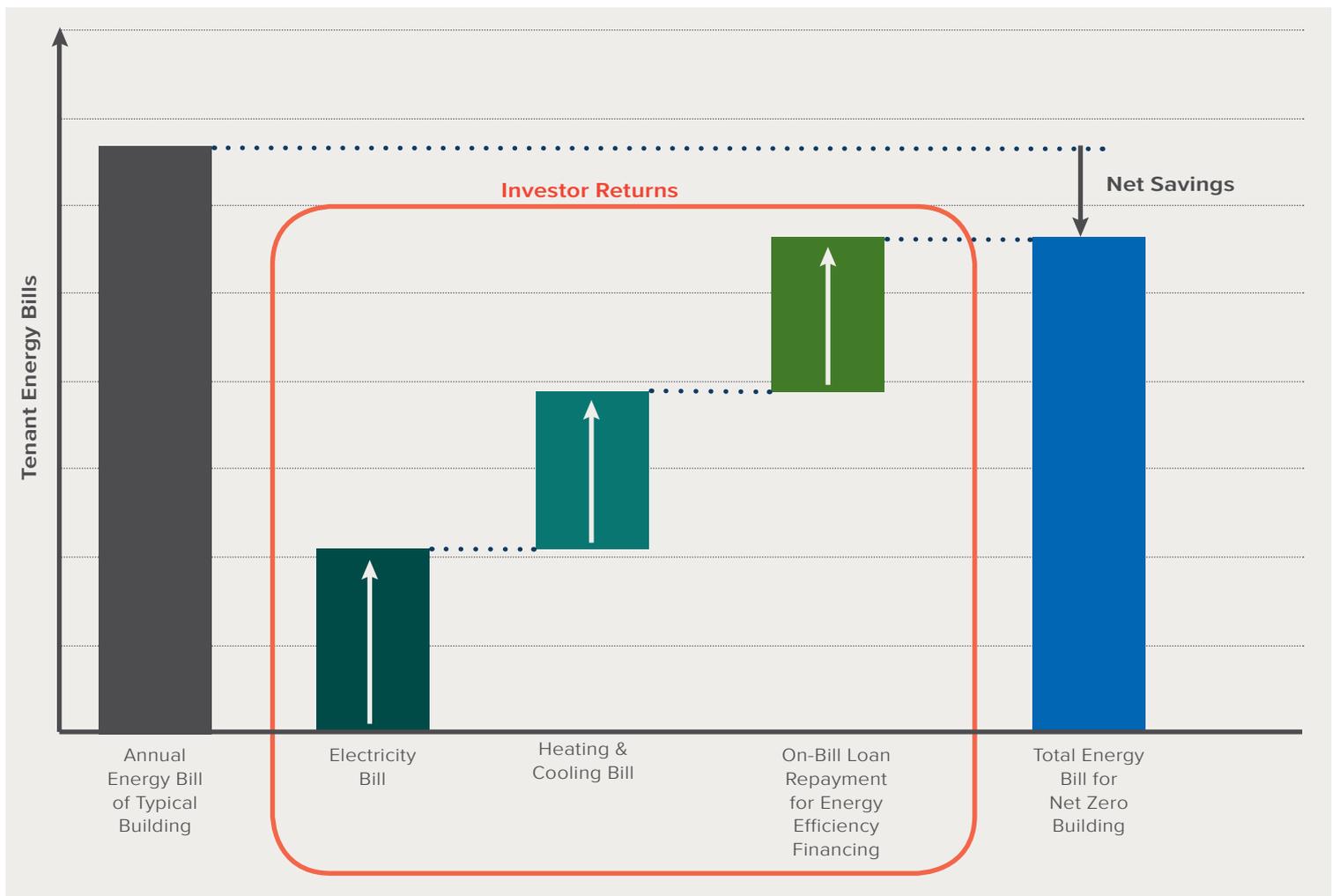
3: TENANTS

Make net zero energy **financially attractive to tenants**. The BAU tenant energy bill is replaced by a net zero energy bill with three components:

1. An electricity bill that includes the third-party-owned PV costs
2. District heating and cooling costs
3. On-bill repayment of the energy efficiency financing

The sum of these three components is lower than BAU, and the tenant inhabits a healthier and more comfortable NZE building.

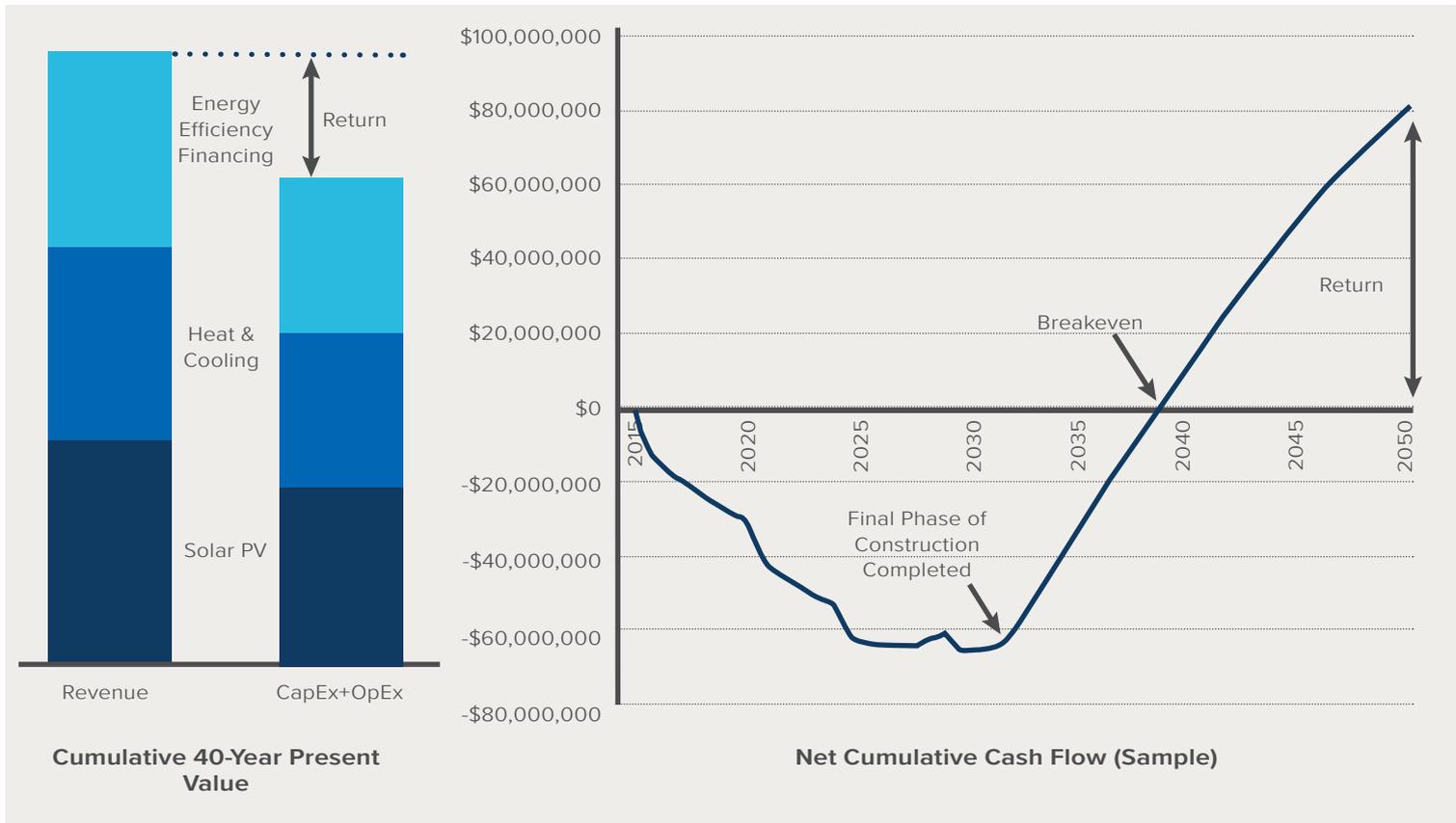
Figure 3: Financially Attractive to Tenants



4: INVESTMENT OPPORTUNITIES

The components of the net zero energy business plan are **financially attractive investment opportunities**. The large capital investments in solar PV, district heating and cooling, and energy efficiency are repaid over time on utility bills, generating a steady return that benefits from enhanced credit because of the utility-customer relationship.

Figure 4: Financially Attractive Investment Opportunities



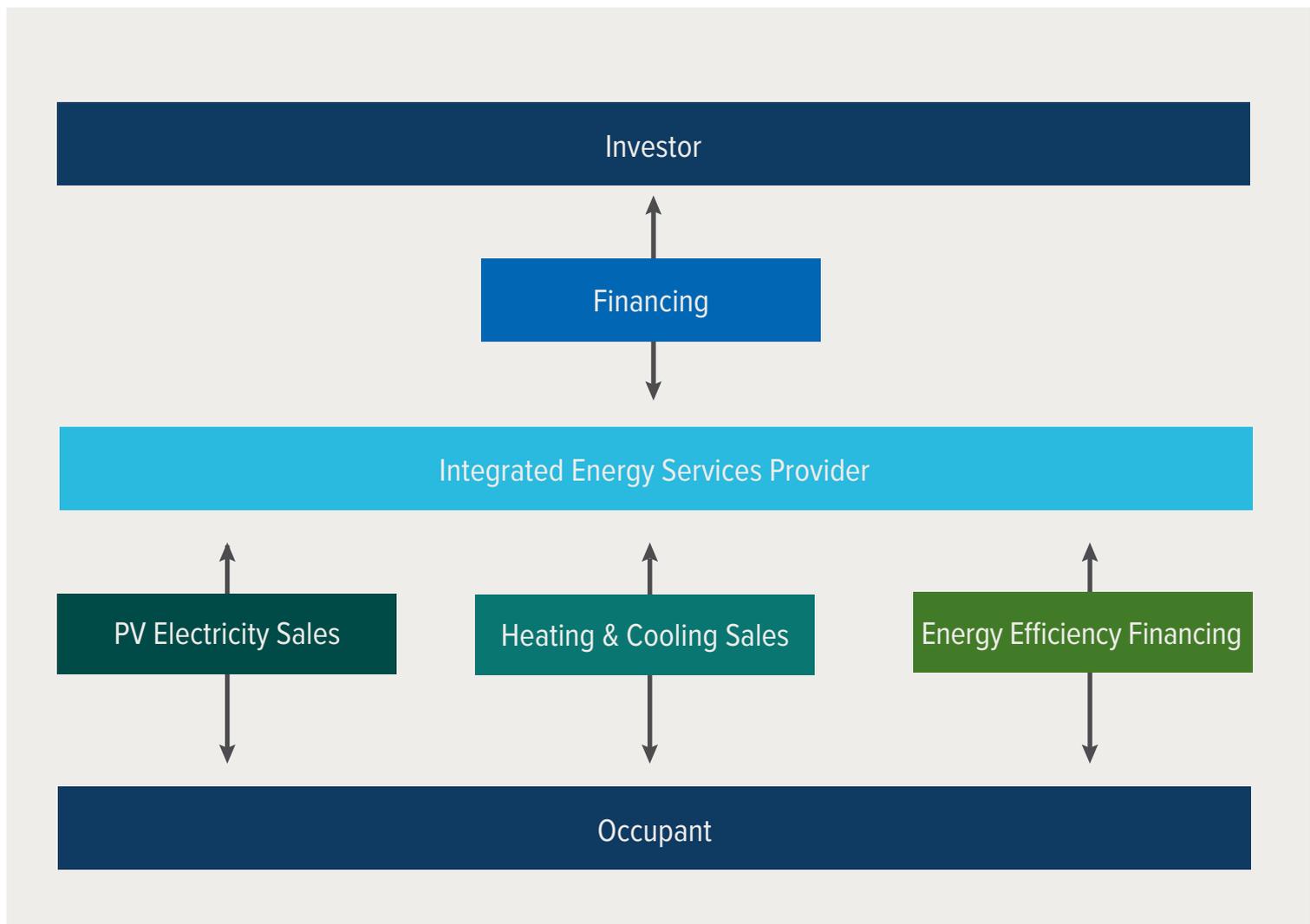
||||| KEY ELEMENTS

The elements of this business plan can be broken into discrete components consisting of services and value streams, as described below. Some of these components are interdependent, while others stand alone.

INTEGRATED ENERGY SERVICES PROVIDER

District-scale developments have a unique opportunity to put in place a dedicated integrated energy services provider (IESP). Such an entity would manage multiple energy-related operations and act as a multipurpose developer, financier, operator, and administrator of energy systems, as well as a regulator of building performance requirements. The IESP may be one organization or multiple organizations acting in cooperation but, in any case, the key is to execute multiple functions in concert to achieve performance objectives in the most economical way, as itemized and detailed below.

Figure 5: Integrated Energy Services Provider and Investor Schematic Diagram



ELECTRICAL MICRO-UTILITY

The IESP is the retail electricity provider to the district's electricity customers, managing electricity supply and conducting customer billing. It functions as an intermediary between the regional electric grid and the district's microgrid, negotiating interconnection terms, ancillary services, demand charges, consumption charges, and feed-in tariffs with the regional utility. This is important in order to capture the value of the unique load and generation characteristics of the ultralow energy development. The micro-utility can also be a platform to optimize flexible loads, thermal storage, and renewable generation, providing valuable services back to the regional grid. Depending on the agreement with the regional utility, the micro-utility may own and operate the district distribution infrastructure. In its most advanced form, the micro-utility could be islandable, continuing operation during regional grid outages.

DISTRICT HEATING AND COOLING

The IESP also develops and operates a central district heating and cooling system. The most efficient systems are geothermal heat pump systems, though other variations might include large-scale, air-source heat pumps or cogeneration of heat and electricity. Compared to individual building plants, district heating and cooling is much more efficient, has lower maintenance costs, is more reliable, and has longer equipment lifetimes. Equally important to this business case, district heating and cooling shifts upfront capital costs from parcel developers to the IESP.

LOAD LEVELING AND HEAT EXCHANGE

Designed correctly, a district heating and cooling system can be used to optimize heating and cooling across a diverse neighborhood building stock. In contrast to individual building systems designed to meet instantaneous peak loads for individual buildings, a district system is designed to meet the collective peak load, which is considerably lower, due to non-coincident peaks across the diverse building stock. This results in smaller overall system capacity and lower first costs. District heating can also be used for heat exchange when there is simultaneous heating and cooling in neighboring buildings. Lastly, the thermal inertia in a large system means that the peak instantaneous power draw, typically driven by air conditioning on the hottest summer day, will be lower, as the peak load is spread out over several hours.

INTEGRATED DEMAND-SIDE MANAGEMENT

The IESP manages multiple megawatts of load at the district heating and cooling plant, which has some degree of intrinsic system load flexibility, and also introduces the possibility for thermal storage that would make the load even more flexible. Demand response capabilities in other building loads, such as lighting, water heating, or plug loads, would make that flexible, demand-side resource even larger. This adds two value propositions: (1) managing peak load for the district to minimize demand charges from the regional utility, and (2) selling "negawatts" of demand response or ancillary services back to the regional electricity market.

OPTIMIZED RENEWABLE ENERGY DEPLOYMENT

The IESP is responsible for all renewable energy development, whether on-site, such as solar photovoltaics (PV), or off-site via power purchase agreements. It can function as the on-site renewable energy developer for ground-mounted, rooftop, or carport-mounted PV. It can then recoup the cost of the system via utility billing to customers. Depending on the regulatory environment, it can negotiate with the regional utility to capture maximum value from the large-scale, on-site generation, which could be in the form of net metering, feed-in tariffs, or simply wholesale into the regional spot market. Having one single solar developer means on-site renewables can be phased and developed en masse, achieving lower costs and capturing economies of scale in mass installations. If the goal of the development is net zero energy, the single renewable developer is able to optimize the timing and location of renewables. Some parcels will not be physically capable of generating as much energy as they consume, and other parcels may be required to generate more than they consume in order for the overall district to achieve district-NZE status. The single solar developer can optimize and maximize across all parcels, then spread the costs and benefits across all parcels equitably. It can also phase renewable deployment in order of cheapest locations first, for example: ground-mounted solar first, then rooftop solar, then the most expensive carport solar last. Alternatively, the IESP could choose off-site renewables or other power procurement options if needed, for example as a stopgap until on-site generation comes down to a critical cost threshold. Comprehensive district-scale urban design allows for optimization of neighborhood building form for maximum solar access. This includes consideration of both solar PV placement and passive solar heat gain to occupied spaces.

DISTRICT-WIDE ENERGY EFFICIENCY FINANCING

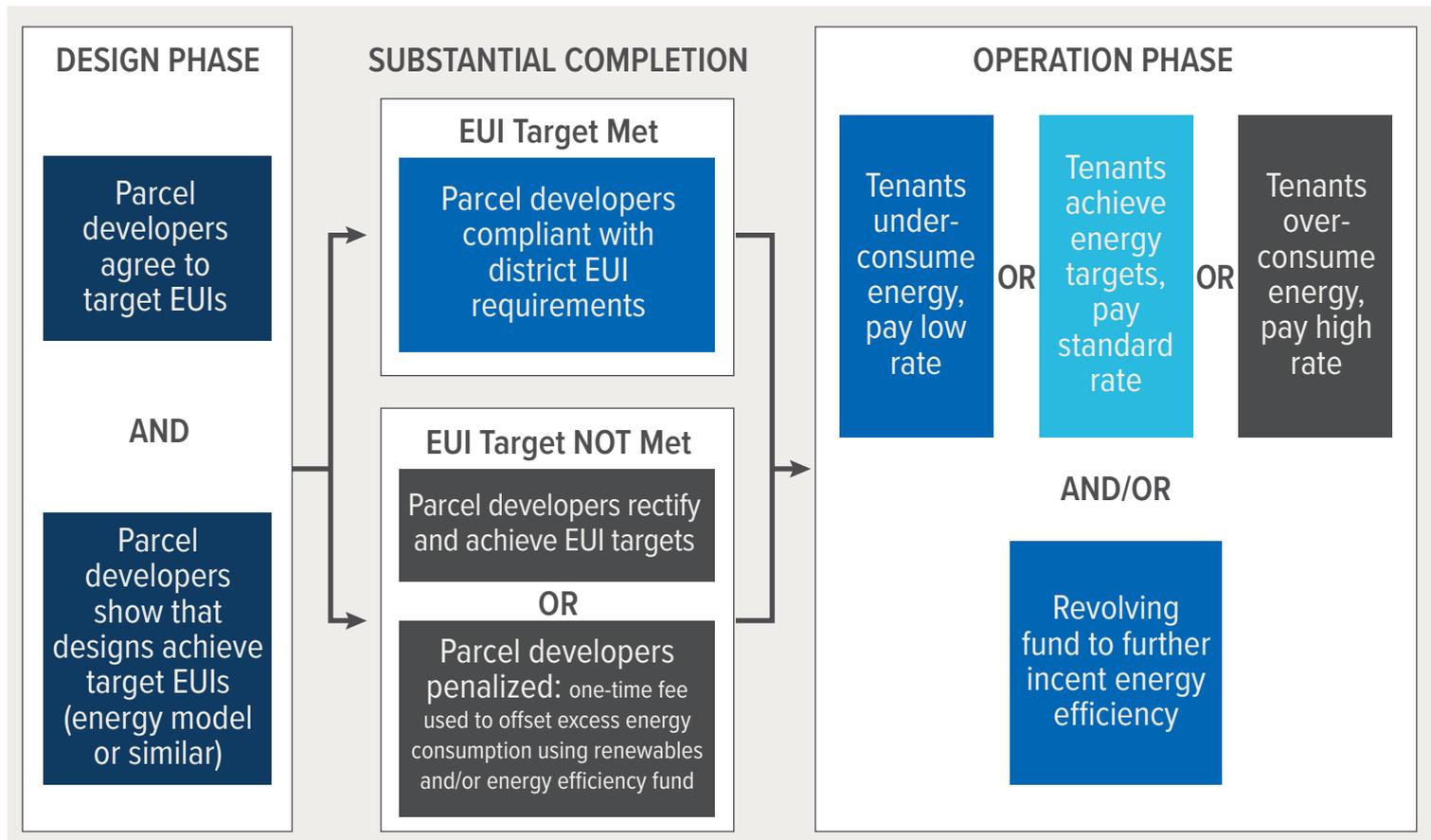
Compared to conventional buildings, superefficient buildings may cost more upfront, as a result of expert integrative design costs, higher-performance envelopes, smart controls, best-in-class systems, and rigorous construction quality, testing, and commissioning. This incremental cost for superefficiency can be financed in the form of a loan from the IESP, relieving the parcel developer of any incremental first costs. That loan can be repaid over time on utility bills by the electricity and district heating and cooling customers who are benefiting from the lower energy bills. The incremental capital investment, and resultant property value, of energy efficiency thus stays with the property. The IESP lender also has recourse against defaulting customers through the utility platform that it operates, making the on-bill financed loans more creditworthy than traditional efficiency loans.

OUTCOME-BASED ENERGY-PERFORMANCE REQUIREMENTS

As part of the contractual arrangement between the district developer and parcel developer, the parcel developer agrees to design, commission, and operate the building to meet stringent, outcome-based energy-performance requirements. These requirements are explicitly defined in terms of energy use intensity (EUI), such as energy use per floor area or energy use per residential unit, and are differentiated by building type and other usage characteristics. For NZE districts, these EUIs may be dictated by the district's on-site renewable energy capacity, which sets an overall energy "budget" for the district.

A system of incentives and penalties is used to regulate the contractual EUI target. At the time of building completion and commissioning, noncompliant buildings have a choice to rectify or to pay a one-time fee. The fee feeds into a fund that is used to implement projects that maintain the district's NZE status by (a) procuring additional renewable energy, or (b) installing energy efficiency measures in other projects, at the discretion of the IESP, which manages the revolving fund. Energy usage is continually tracked during the operation of the building. To motivate compliance during operation, the IESP institutes tiered energy billing rates, with lower rates for buildings that meet or exceed requirements and increasingly higher rates for noncompliant buildings.

Figure 6: Incentivizing Building Efficiency



MOBILIZE LOCAL BUILDING INDUSTRY

While many NZE and ultralow energy buildings have successfully been built as isolated projects in dispersed locations, the large scale of a NZE district development has an economic advantage in that it can motivate and mobilize a local building industry, driving down incremental costs. It can drive workforce training and capacity building and can achieve economies of scale in the mass deployment of best-in-class strategies and technologies across a large portfolio of similar high-performance buildings.

DISTRICT DESIGN FOR SUSTAINABLE TRANSIT

Comprehensive district-scale design also includes transit planning. Strategic density, live/work adjacency, biking and public-transit infrastructure, transit data platforms, and electric vehicle charging infrastructure represent major opportunities to drive sustainable modes of transit.

RESILIENCE

It is a natural extension to imagine the IESP evolving to a more advanced microgrid, including the ability to operate as an island during broader regional grid outages. Such resilience could be a valuable service not only to residents, but also to businesses, industries, or data centers that benefit financially from avoided downtime. In a broader definition of economic resilience, an ultralow energy district with renewable electricity generation can be insulated from fossil fuel price volatility.

COMFORT, HEALTH, AND LIVABILITY

Last, but perhaps most valuable, holistic planning of sustainable buildings and districts improves quality of life and productivity. High-performance buildings should be more comfortable, have more natural daylight, and have better indoor air quality. All of those attributes have been proven to measurably improve occupant health and increase worker productivity, a financial value that far exceeds energy cost savings. High-performance buildings and livable communities have been shown to achieve higher rental premiums and occupancy rates.

||||| BARRIERS

PHASING

Large-scale developments are often built in phases, and within those phases, there is often uncertainty about the order or speed with which parcels are sold off and developed. Yet some components of a district energy system—the central plant, the heat sink or heat source for a chiller or heat pump, and the distribution system—must be constructed with a single, large capital investment.

This creates two challenges:

1. Large capital investments are being made to build systems that may not come into service (or be utilized at their full capacity) for many years, while generating no return in the meantime.
2. District energy developers or lenders may be reluctant to invest in a speculative development that does not yet have customers. They might also have concerns that future parcel developers could hypothetically opt out of the district energy service.

Solutions:

1. Dividing, phasing, and delaying subcomponents of large capital investments as much as possible.
2. Utilizing early take-or-pay contracts with a major anchor customer or with the district developers themselves.
3. Selling base-load or excess heating or cooling to existing adjacent neighborhoods, thus diluting the risk of a speculative development.

4. Mandating that buildings must utilize district energy systems in parcel developer contracts, subject to IESP compliance with pricing and performance standards.
5. “Sculpting” capital financing to match revenue cash flows as they grow over time.

UTILITY REGULATIONS

There may be regulatory hurdles to creating a micro-utility. First, for the micro-utility to be successful, it must be allowed to mandate that tenants use it as the retail electricity provider, which may not be straightforward in all regulatory environments. Second, in order to maximize the value to the grid of load leveling, peak reducing, and integrated demand-side management, the regional utility must be supported by the appropriate regulatory environment in order to value those services. Third, net metering of rooftop solar generation may not be feasible or allowed for a large development aggregating many buildings into one single connection to the regional electric grid.

Solution:

A large, sophisticated customer, such as the IESP, is likely in a position to negotiate with the regional grid operator. It should also demonstrate that smart management of the district loads and microgrid could actually be valuable to the regional utility. The large scale of such a development could also position the IESP to benefit from—or even drive—broader local or regional energy planning programs or pollution mitigation policy.

SMALL LOADS

Ultralow energy loads could actually make it difficult to justify the large investment in the distribution infrastructure associated with a central heating and cooling plant.

Solution:

This is a legitimate concern warranting careful analysis. District energy developers should be prepared to analyze and pinpoint the economical threshold of load density. The district system can also explore servicing neighboring communities beyond the development boundaries, broadening the customer base and increasing the load.

||||| CASE STUDY

Modeling of this business case was solicited by a specific development. That location sees relatively low electricity rates and relatively cheap natural gas, and the grid interconnection arrangement modeled assumed no net metering of rooftop solar generation. Those factors, nearly a worst-case scenario for this NZE business model, would tend to favor a business-as-usual scenario, with buildings and equipment of average efficiency. Nevertheless, the economics of this NZE business model are still favorable. First costs and annualized life-cycle costs are both on par or cheaper than business as usual, as illustrated for one example building type below.

Case study development overview:

- 180 acre (72 ha) brownfield site
- 6 million gross ft² (560,000 m²) of building floor area
- 60% residential, 30% office, 10% other
- Mostly four- to eight-story buildings

Figure 7: Parcel Construction Costs – Mid-Rise Residential

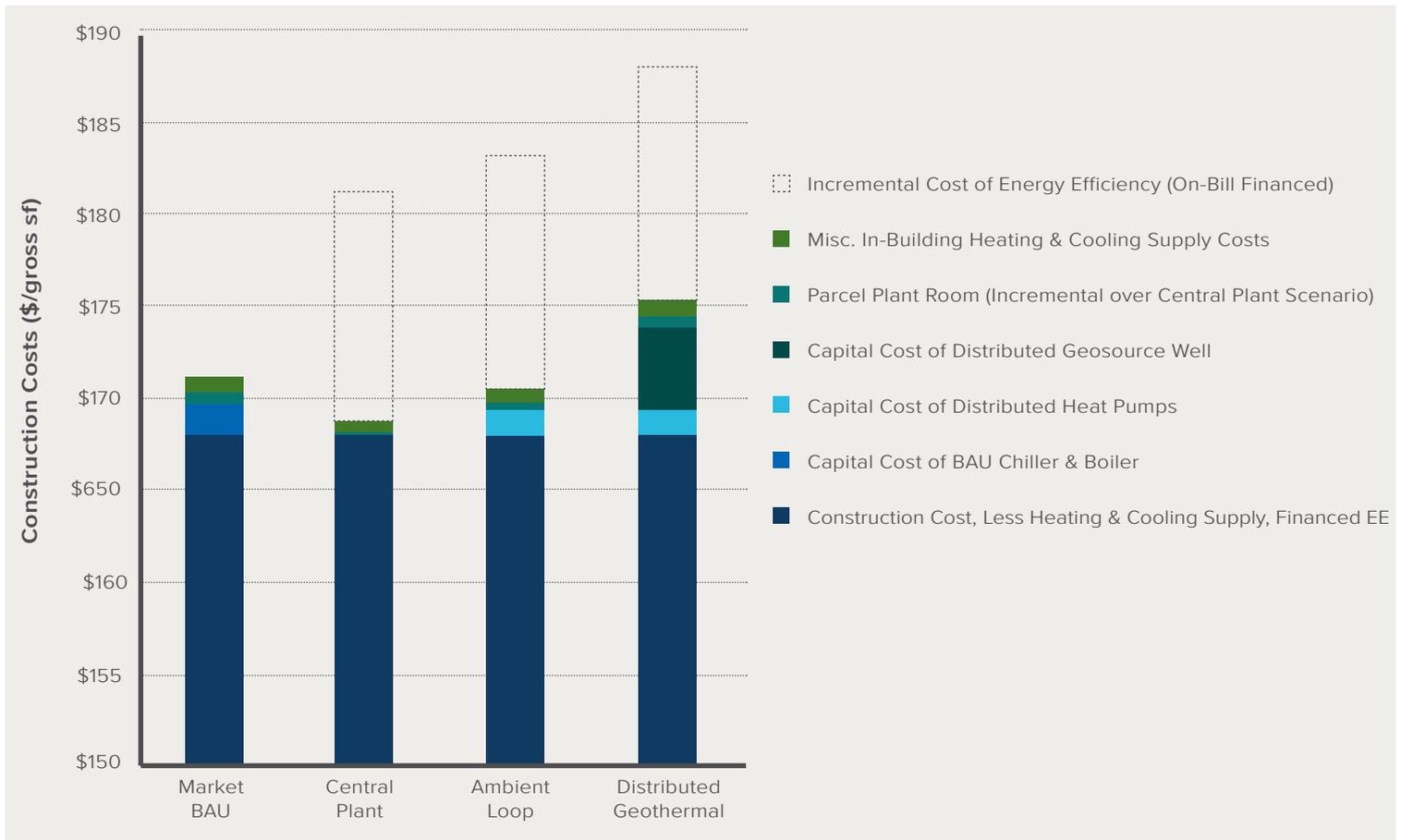
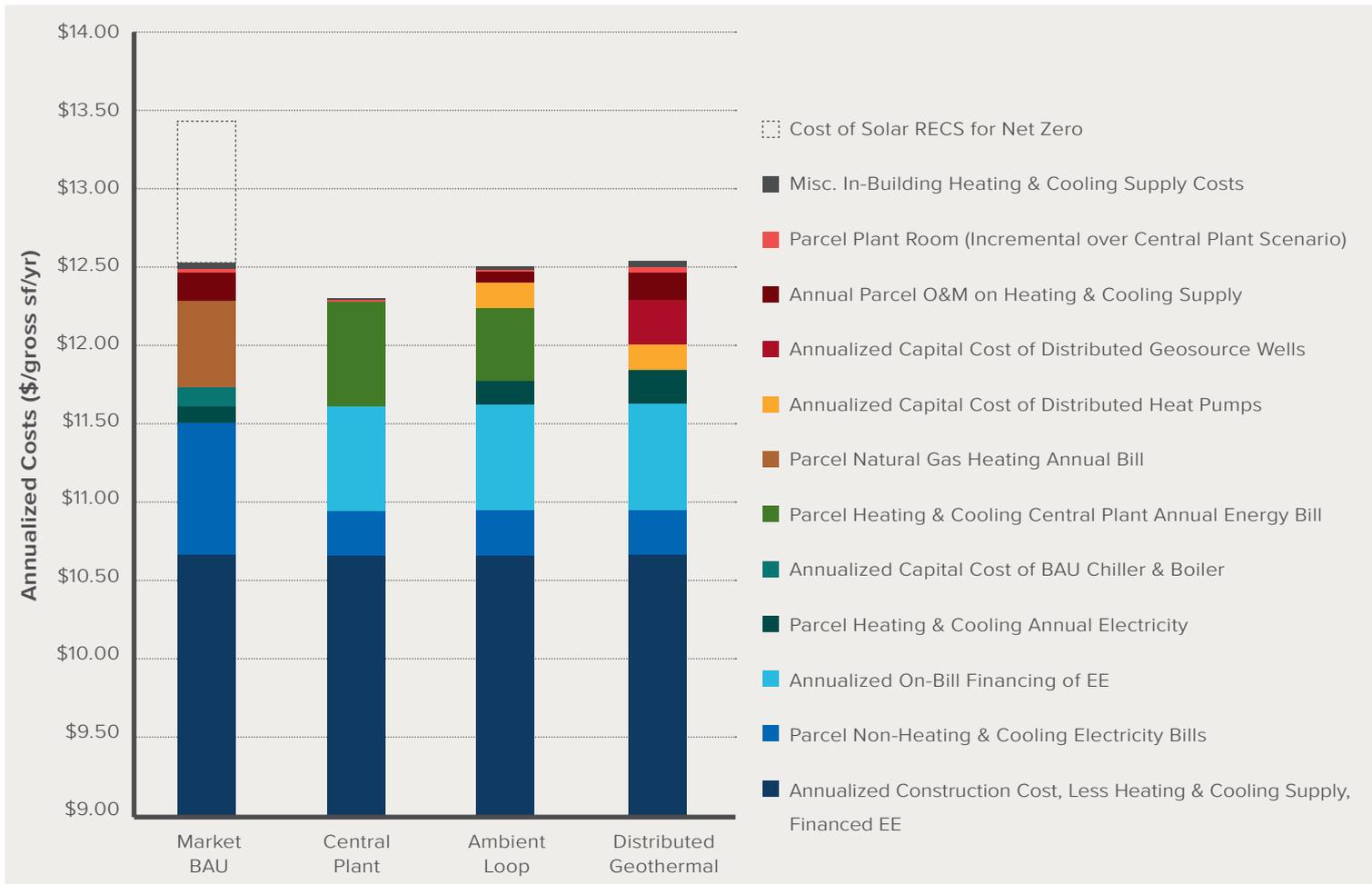
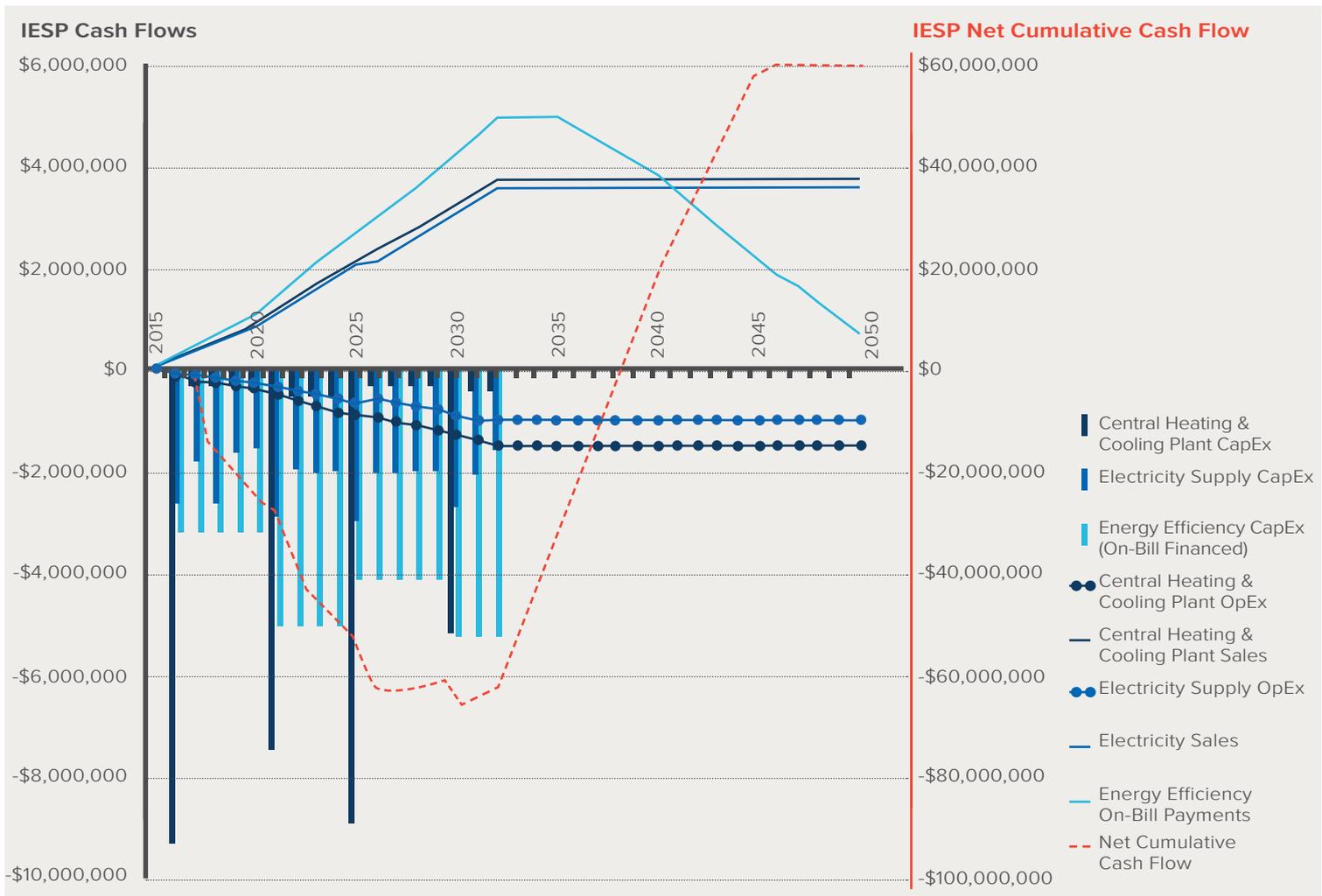


Figure 8: Parcel Amortized, Annualized Costs – Mid-Rise Residential



Per-unit electricity and district heating and cooling prices are, in fact, higher than regional averages due to several factors, such as the lack of net metering on rooftop solar and the costly energy distribution systems (both electrical and heating and cooling) that service relatively small loads. However, consumption is much lower than typical buildings and, even including the (financed) incremental costs of energy efficiency, total amortized and annualized costs to tenants are on par or lower than a business-as-usual case with standard electricity service and heating and cooling equipment.

Figure 9: Sample IESP Cash Flows (For a Phased Development)



||||| CONCLUSION

District-scale developments are uniquely positioned to be a major driver of the next generation of high-performance buildings and an intelligent electric grid, and to benefit financially from such leadership. Not all of the value elements of this business case will pertain to every large-scale development, given variations in size, use types, regulatory environments, project goals, energy prices, access to capital, and operator sophistication. But stand-alone components or hybrids of this model can still be valuable, especially under the guidance of an IESP that plays an integrative role in value capture and creative financing, making such developments attractive to investors, developers, and tenants alike.

ABOUT ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. In 2014, RMI merged with Carbon War Room (CWR), whose business-led market interventions advance a low-carbon economy. The combined organization has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.