

# Smart, Flexible, Affordable Clean Energy for Chicago

A Proposal for Energy Efficiency Retrofits and a District  
Scaled High-Efficiency Air Source Heat Pump Solution

by Blacks In Green

February 2022



# A Proposal for Energy Efficiency Retrofits and a District Scaled High-Efficiency Air Source Heat Pump Solution

**We see our concept proposal as a low-hanging fruit opportunity to accelerate efforts to deliver clean, affordable energy solutions to our neighbors. It is also a viable “no regrets” option.**

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# First Steps

## Process for Realizing Just & Equitable Solutions

BIG and our Green Power Alliance members are engaged in decarbonization efforts in Illinois and the Mid-west region. Stakeholders from a broad cross-section of the clean energy sector have engaged with us to explore collaborations and offer a wide variety of technological solutions to energy transition and climate change. They include research institutions, energy efficient appliance manufacturers, clean energy developers, renewable energy associations, and environmental non-governmental organizations. These engagements have informed our understanding of some of the technological solutions available for responding to the urgent needs facing residents in our immediate community of Woodlawn. They have also led us to a very clear understanding of the need to center community, to create an enabling environments for community voices to be brought into decision-making about solutions being proposed for our communities. It is also imperative that stakeholders are required to adhere to performance metrics for equity and that these must be baked into the policies, business models and implementation plans considered by the City, State, federal government and other actors. It is clear that only a just transition will be affordable,\* and there is an urgent need for standards around how equity and climate justice are conceptualized and delivered, and by whom?



# Making the Case

- ✓ High Energy Burden Prevalence in Chicago
- ✓ Utility Disconnections & Extreme Economic Stress
- ✓ The Role of Limited Access to Affordable Energy Options (.e.g., Solar)
- ✓ Available Technical and Economic Energy Efficiency Potential in ComEd's Service Territory
- ✓ Broad Technical Support for High Efficiency Air Source Heat Pumps





# Neighborhood Context

## Property Ownership, Rentals & Affordable Housing

- ✓ Only 36% of West Woodlawn's residents own their homes.
- ✓ Over 50% of property owners live outside of the neighborhood.
- ✓ There is a higher percentage of renters than property owners.
- ✓ The percentage of affordable housing units in West Woodlawn is greater than that of the City of Chicago, overall.
- ✓ Non-resident property ownership increased in West Woodlawn between 2013 and 2016.
- ✓ Property values increased 23% within six months of the announcement of the Obama Presidential Library and District, nearby.

**There is high potential for gentrification and displacement of the local low-income residents without proper programming and intervention as renewable energy and climate resilient pilots and projects take root.**

Changes in West Woodlawn Property Ownership, 2013-2016



- Property Ownership**
- No Ownership Change
  - Ownership Change
  - City of Chicago
  - No Data

0 145 290 580 870 1,160 Feet

Source: *Who Owns West Woodlawn*, A 2013-2016 Land Ownership Study completed by Geography Dept. at DuPaul University, commissioned by BIG.

# Woodlawn Household Income Starting Where We Are

## Household Income, 2015-2019

	Woodlawn		City of Chicago		CMAP Region	
	Count	Percent	Count	Percent	Count	Percent
<b>Less than \$25,000</b>	4,596	49.5	259,714	24.3	529,858	17.0
<b>\$25,000 to \$49,999</b>	1,815	19.5	212,433	19.9	567,834	18.2
<b>\$50,000 to \$74,999</b>	1,102	11.9	160,900	15.1	490,586	15.7
<b>\$75,000 to \$99,999</b>	744	8.0	119,199	11.2	395,676	12.7
<b>\$100,000 to \$149,999</b>	635	6.8	146,765	13.8	533,771	17.1
<b>\$150,000 and Over</b>	402	4.3	167,818	15.7	605,605	19.4
<b>Median Income</b>	\$25,450		\$58,247		\$73,572	
<b>Per Capita Income*</b>	\$19,493		\$37,103		\$39,058	

Source: 2015-2019 American Community Survey five-year estimates.

Universe: Occupied housing units

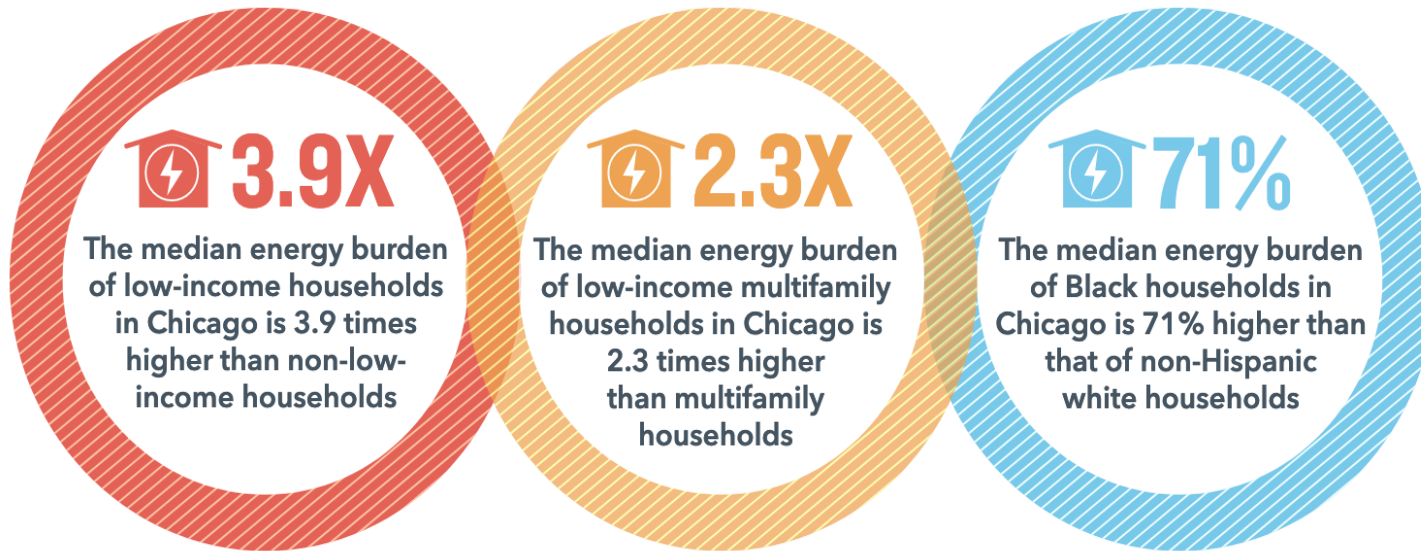
\*Universe: Total population

Almost half of Woodlawn households earn less than \$25k/year, compared to 24.3% for the City and 17% for the Chicago Metropolitan region. Median income in Woodlawn is \$25,450/year compared to \$58,247 and \$73,572 for the City and Region, respectively.

Source: Statistical Atlas <https://statisticalatlas.com/neighborhood/Illinois/Chicago/West-Woodlawn/Household-Income#figure/median-household-income-by-race>

# Energy Burden Prevalence in Chicago

Energy Burdens: Affordability = Safety, Comfort, Life



“[O]utdated electric circuits; the crowding for warmth in cramped quarters. Blocked exits become death traps. Failed smoke detectors become silent killers.”

Source: <https://www.bettergov.org/news/greising-since-2014-at-least-61-people-died-in-buildings-with-fire-safety-dangers-known-to-city/>



# Utility Disconnections & Extreme Economic Stress

Consequences of Inadequate Access to Affordable Energy

# Not Enough Access to Affordable Energy Options

At-risk Customers Have Poor Access to Affordable, Clean Energy due to Distributional Disparities

# Paying More for Lack of Access to Solar?

The Most At-risk Customers May Be Paying More Than Their Fair Share for Energy

# ComEd's Energy Efficiency Potential Study

There is Significant Unrealized Technical and Economic Potential for Energy Efficiency Improvements

There is Significant Technical and Economic Potential for Residential Savings from Heating Ventilation and Air Conditioning and Other Energy Efficiency Improvements – Even Excluding Income-Eligible Households

There is Substantial Potential for Commercial & Industrial Savings from Heating Ventilation and Air Conditioning Energy Efficiency Improvements.

## A Key Observation from ComEd's EE Potential Study

“While fuel-switching is not included in the study's scope, multiple heat pump measures are modeled in order to account for both the opportunity related to adding a standard-efficiency heat pump to replace electric resistance heating in homes, and the selection of a higher-efficiency model whenever a household chooses to replace or add a heat pump. ***Even if the current penetration of electric heating is low in***



# A Scalable Model: A High-Efficiency Air Source Heat Pump Solution

- ✓ BIG's model starts with development of a flexible, accessible, high-efficiency air source heat pump solution and is well supported by both the urgent, unmet energy-related health, safety, comfort and affordability needs of Woodlawn and other Chicago households.
- ✓ The solution is scalable – can be used traditionally as a single building solution or grouped to serve as a shared heating and cooling system for clusters of homes, duplexes, multifamily buildings, neighborhood blocks or integrated into a larger neighborhood microgrid network.



# A Scalable Model

## Initial Approach

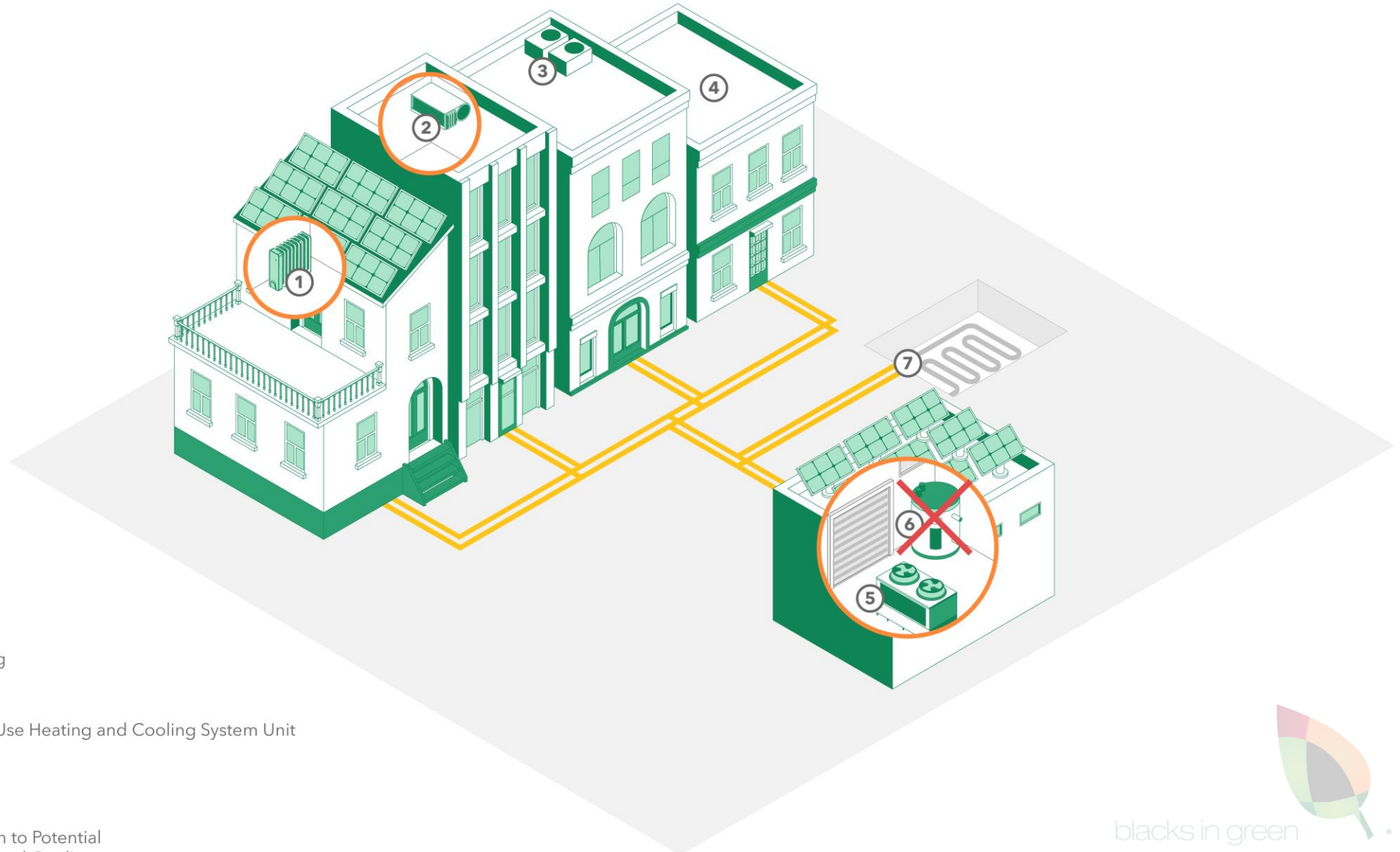
- ✓ Group multiple single-family homes (SFR) or Chicago two-flats (duplexes) together to *share energy heating and cooling system across buildings*.
- ✓ The group of buildings *share a large air source heat pump*.
- ✓ Each residential unit has a water source heat pump and a domestic hot water tank.
- ✓ There is flexibility to add a large shared thermal storage tank allowing *more efficient energy sharing*. *Need* to evaluate to determine benefit .
- ✓ Possibly add an “anchor” non-residential building to *balance out heating and cooling* use.
- ✓ Possibly add electric *boiler for peak days* (depending on building loads and air-source heat pump used).

## Technical Approach

- ✓ **Heating**
  - ✓ Air-source heat pump provides low temperature hot (80°F) water
  - ✓ Residential unit water source heat pumps provide the additional heat required (130-180°F)
- ✓ **Cooling**
  - ✓ Air-source heat pump provides chilled water
  - ✓ Residential or nit water source heat pumps further lower temperature
  - ✓ Unit domestic hot water tanks receive “waste heat” from cooling

*(A further study is required to determine the correct balance of systems.)*

# SFR and Two-Flats



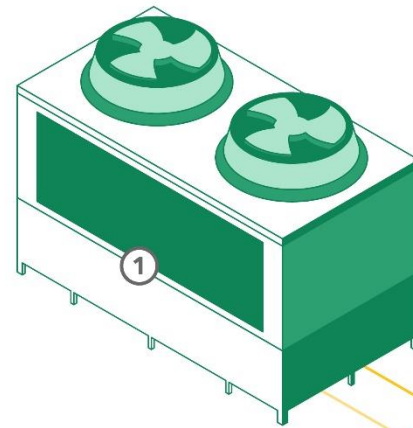
# Single Family (SFR) and Two-Flats System Map

## Heating

Air-source heat pump provides low temperature hot (80°F) water at optimized efficiency (COP)

## Cooling

Air-source heat pump provides chilled water at optimized efficiency temperature if at all



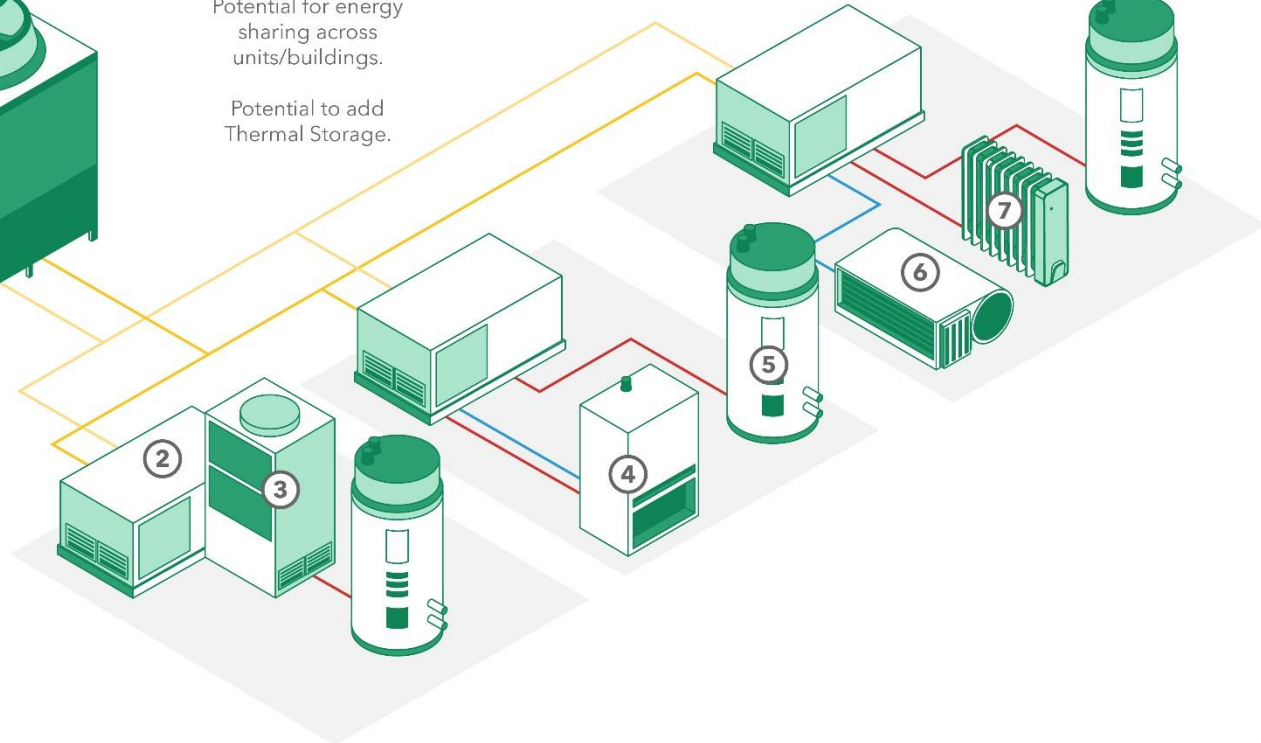
Potential for energy sharing across units/buildings.

Potential to add Thermal Storage.

Water source heat pumps provide additional heat to 130-180°F

Water source heat pumps further lower temperature as required

Unit domestic hot water tanks receive "waste heat" from cooling



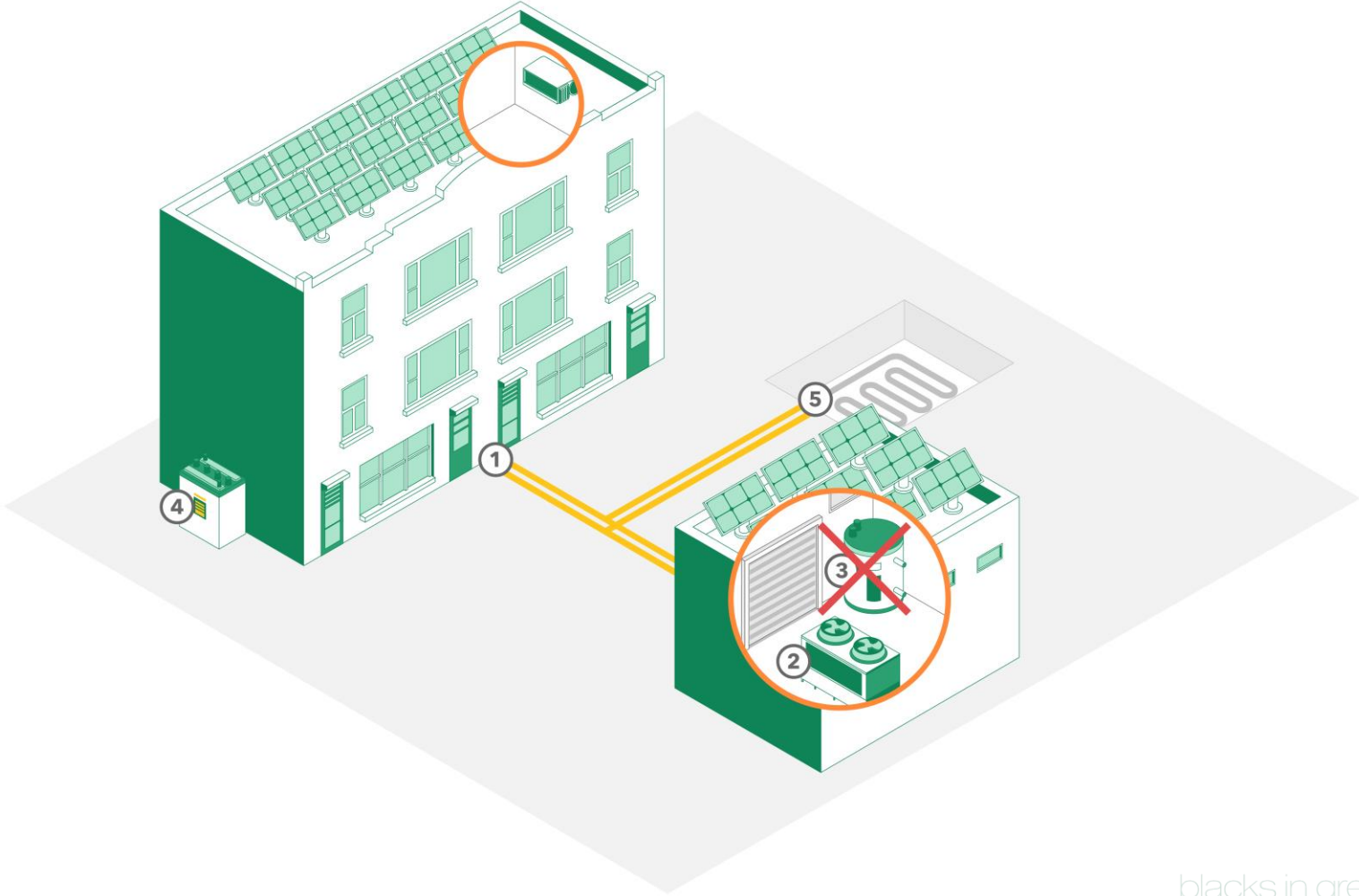
- ① Air Source Heat Pumps
- ② Water Source Heat Pump
- ③ Retrofit or New Construction Air Handler (Central Air)
- ④ Existing Air Handling Unit
- ⑤ Domestic Hot Water Heater
- ⑥ Retrofit Fan Coil Unit
- ⑦ Cast Iron Radiator

# House as A Garden ~ Multi-Use Residential



- ① House As Garden
- ② Air Source Heat Pumps
- ~~③ Thermal Storage~~
- ④ Battery Storage
- ⑤ Flexible System for Future Connection to Potential Ground-source Geothermal Heating and Cooling

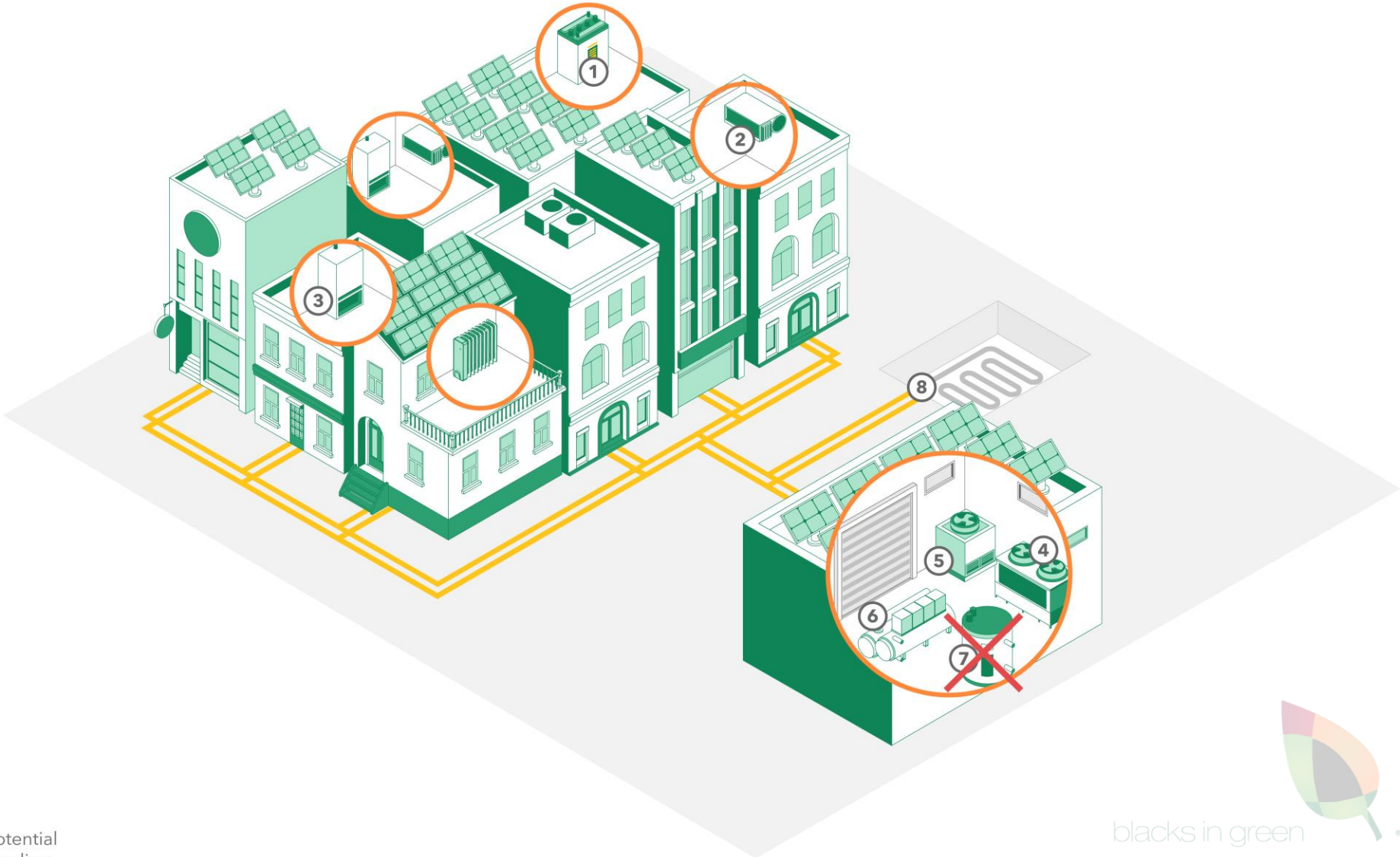
# Mixed-use Building – Green Living Room



- ① Mixed-use building
- ② Air Source Heat Pumps
- ~~③ Thermal Storage~~
- ④ Battery Storage
- ⑤ Flexible System for Future Connection to Potential Ground-source Geothermal Heating and Cooling



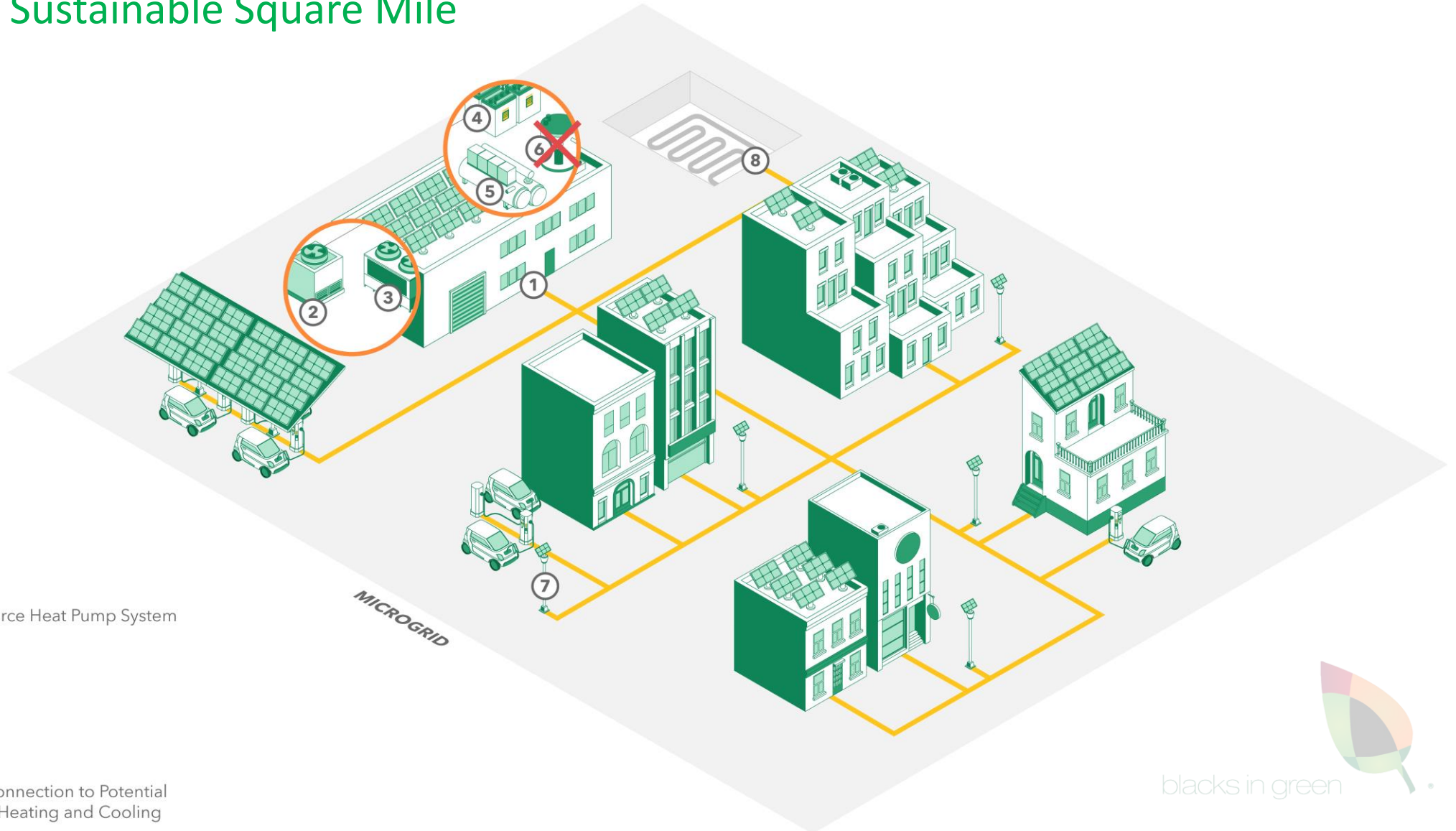
# Neighborhood Block



- ① Battery Storage
- ② Fan Coil
- ③ Air Handler
- ④ Air Source Heat Pumps
- ⑤ Cooling Tower
- ⑥ Heat Recovery Chillers
- ~~⑦ Thermal Storage~~
- ⑧ Flexible System for Future Connection to Potential Ground-source Geothermal Heating and Cooling

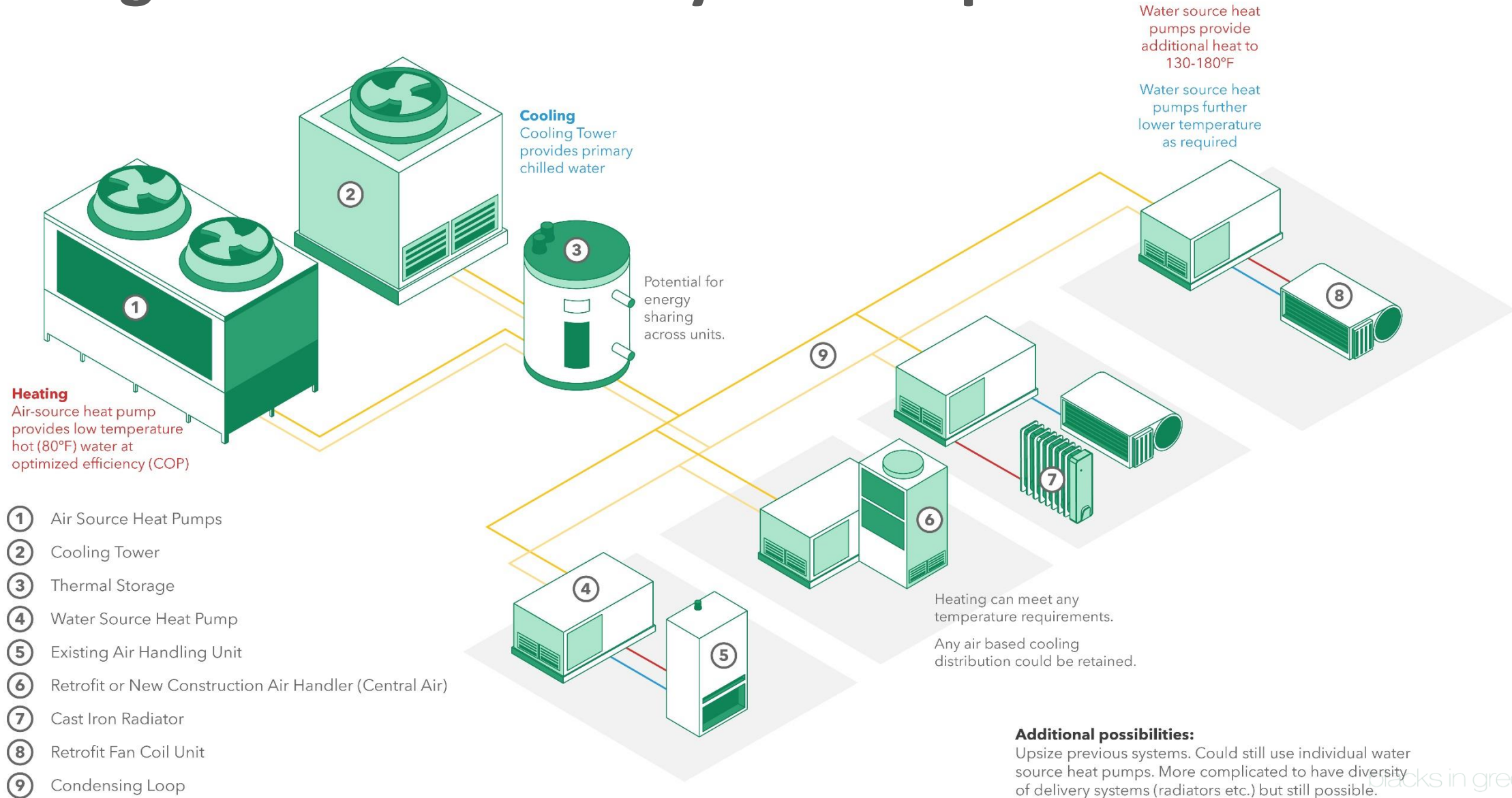
# Integrated Microgrid w/ Neighborhood Heating & Cooling

## Concept for a Sustainable Square Mile



- ① Microgrid Controller
- ② Cooling Tower
- ③ Neighborhood Scale Air Source Heat Pump System
- ④ Energy Storage
- ⑤ Heat Recovery Chillers
- ~~⑥ Thermal Storage~~
- ⑦ Micro Solar Panel
- ⑧ Flexible System for Future Connection to Potential Ground-source Geothermal Heating and Cooling

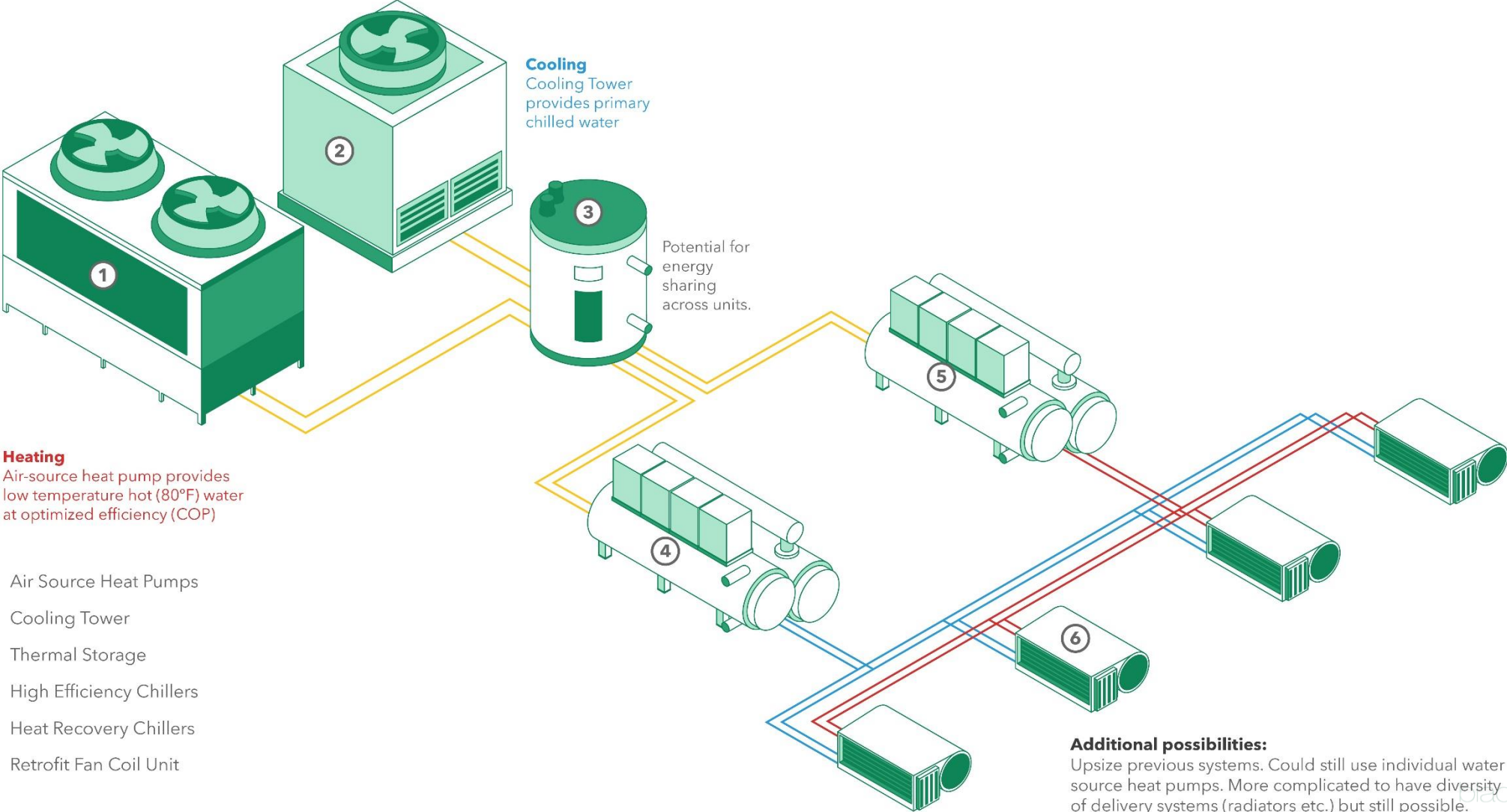
# Neighborhood Block – System Map



- ① Air Source Heat Pumps
- ② Cooling Tower
- ③ Thermal Storage
- ④ Water Source Heat Pump
- ⑤ Existing Air Handling Unit
- ⑥ Retrofit or New Construction Air Handler (Central Air)
- ⑦ Cast Iron Radiator
- ⑧ Retrofit Fan Coil Unit
- ⑨ Condensing Loop



# Integrated Microgrid – System Concept Map



- ① Air Source Heat Pumps
- ② Cooling Tower
- ③ Thermal Storage
- ④ High Efficiency Chillers
- ⑤ Heat Recovery Chillers
- ⑥ Retrofit Fan Coil Unit



# Next Steps

## Feasibility Studies & Modeling

BIG is interested in partnering with the City and ComEd to explore:

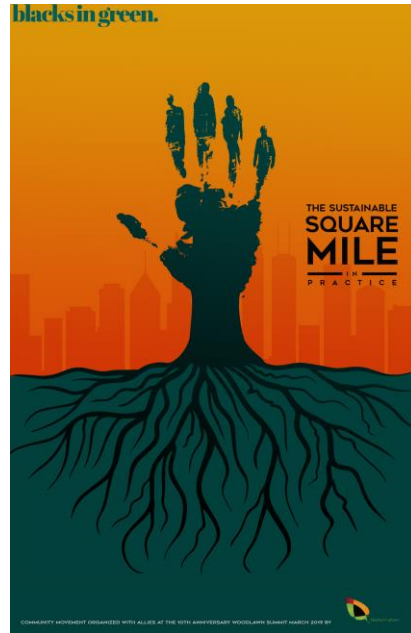
- 1) Opportunities for data sharing
- 2) Support for completion of a life-cycle cost analysis, load modeling and on-bill cost analysis to inform further development of BIG's shared Air Source Heat Pump pilot. Such feasibility studies must be completed to refine and phase the proposal and to explore capital stacking of available utility and non-utility funding sources for implementation. These studies will provide data on the actual conditions in homes in the Woodlawn Sustainable Square Mile.

# Sustainable Square Mile

## A Vision Evolving

**Contact Us!**  
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[twitter.com/blacksingreen](https://twitter.com/blacksingreen)  
<https://www.facebook.com/BlacksInGreen>  
<https://www.blacksingreen.org>



### West Woodlawn Botanic Garden Village Farm & Arboretum

*Only a whole-system solution can transform the whole-system problem common to black communities everywhere.*

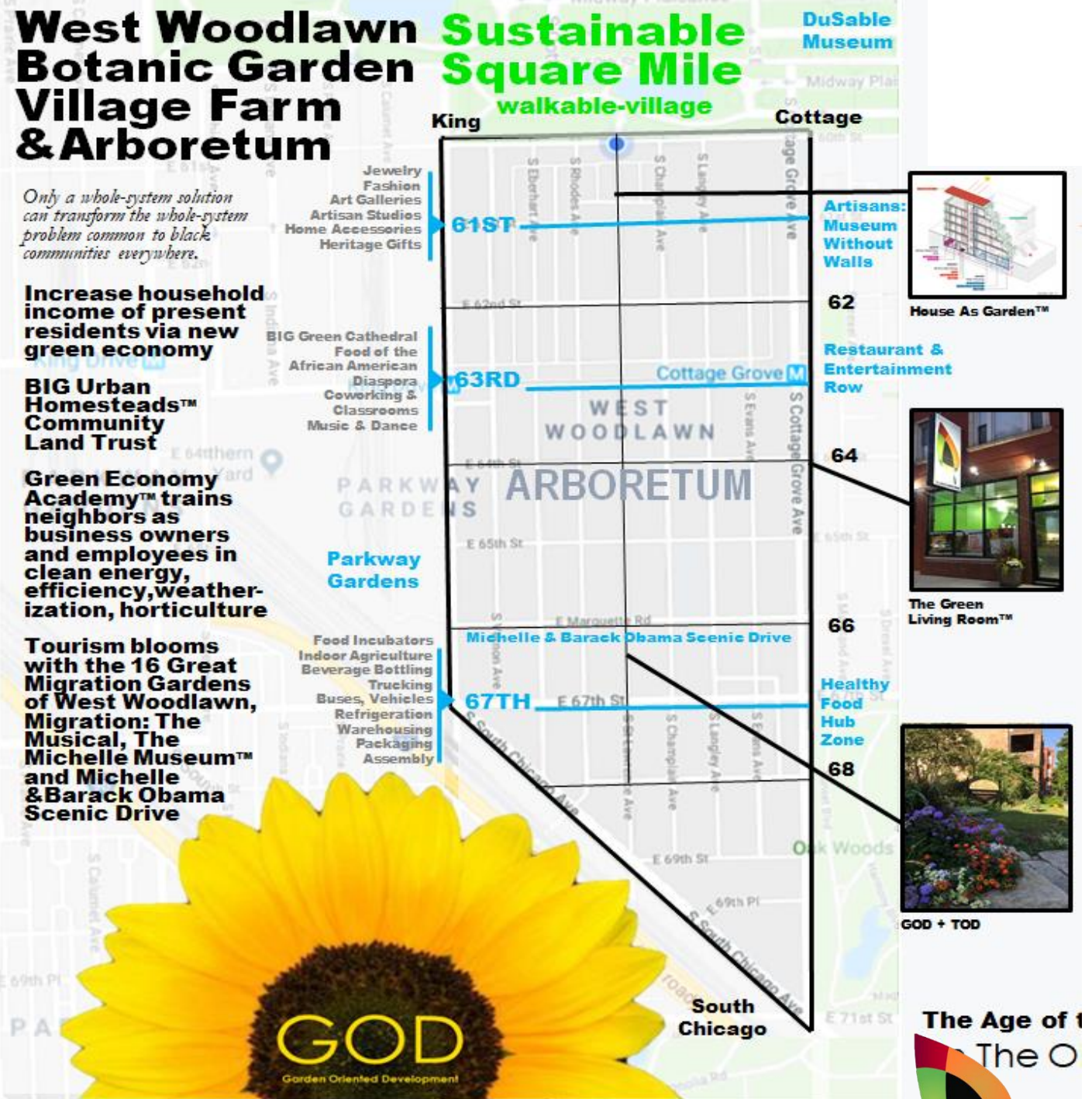
**Increase household income of present residents via new green economy**

**BIG Urban Homesteads™ Community Land Trust**

**Green Economy Academy™ trains neighbors as business owners and employees in clean energy, efficiency, weatherization, horticulture**

**Tourism blooms with the 16 Great Migration Gardens of West Woodlawn, Migration: The Musical, The Michelle Museum™ and Michelle & Barack Obama Scenic Drive**

### Sustainable Square Mile walkable-village



House As Garden™



The Green Living Room™



GOD + TOD

The Age of 1  
The O