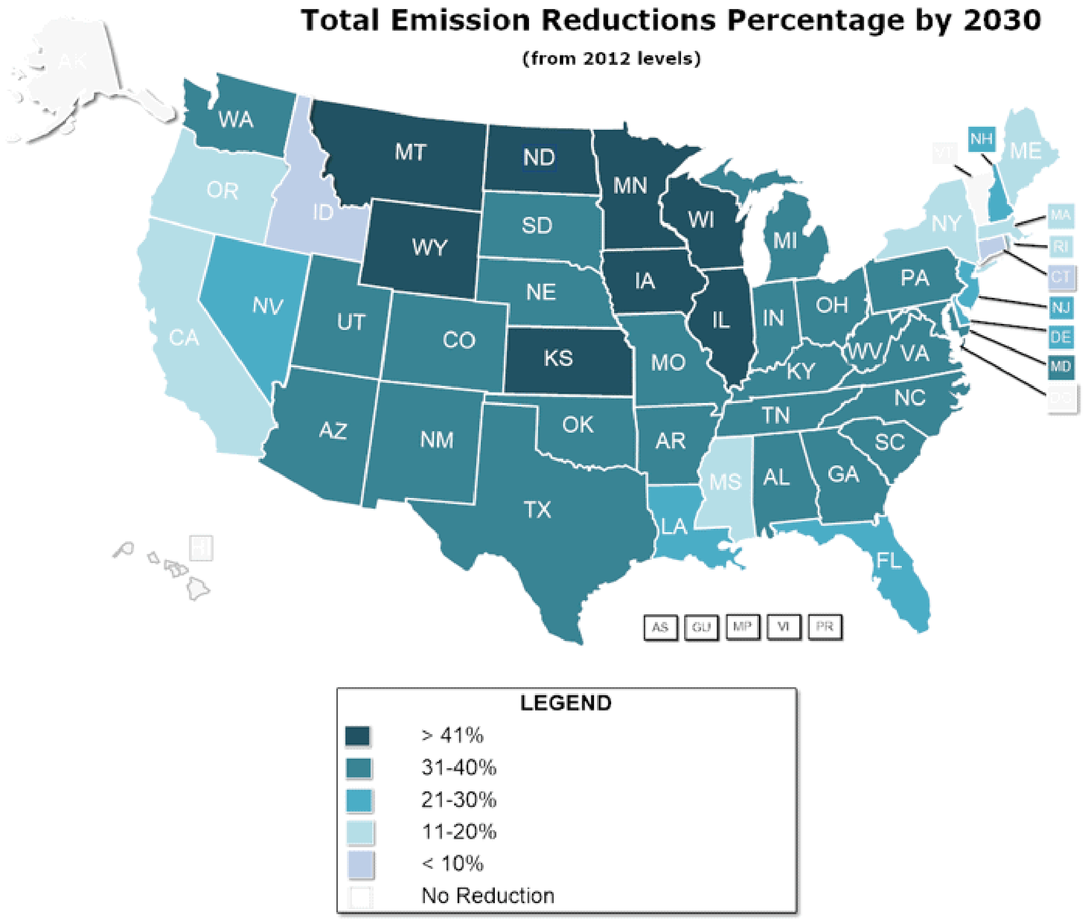
PLANNING PITTBURGH'S PATHWAY

REDUCING CARBON EMISSIONS AND INCREASING ECONOMIC DEVELOPMENT VIA DECARBONIZATION

YET WE KNOW THAT THE ENERGY THAT WE CONSUME COMES FROM WAY BEYOND OUR BORDERS; THEREFORE, WE NEEDED TO UNDERSTAND OUR "EMISSIONS FOOTPRINT" VS WHAT WE CAN TANGIBLY CHANGE

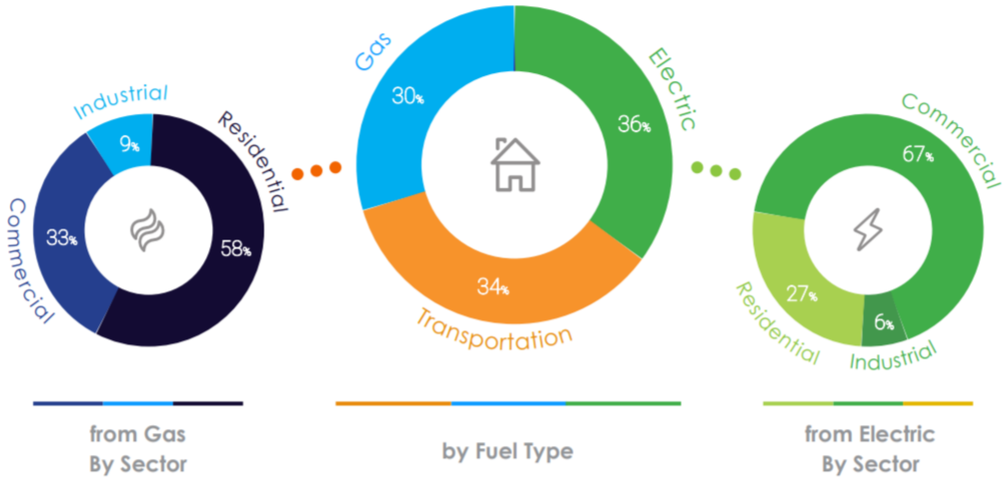


- Pennsylvania is suggested under the CPP to reduce its emissions by 29 million tons, or 24 percent below 2012 levels, by 2030
- This represents a **33% reduction in CO2 from 2005 levels**
- PA is nearly halfway there- we cut emissions by 16% from 2005-2012
- 38% of PA's electricity generation came from nuclear power, 36% from coal, and 22% from natural gas in 2011; however, coal went down (so did CO2!)
- Hydropower, wind, and solar make up roughly 4% of all other power
- **Pennsylvania will need to build 4,370 MW of wind capacity and nearly 6,400 MW of solar capacity including almost 2,000 MW of rooftop solar on homes and businesses to meet the CPP goals; therefore a large portion of our goals depends on the state's energy shift**
- PA has Renewable Portfolio Standard Policies: 18% requirement by 2021
- PA also has Solar/Distributed integration requirements including 0.5% PV by 2021

DEFINING PITTSBURGH'S ENERGY FOOTPRINT WITHIN THE PA CONTEXT

WHEN LOOKING THEREFORE AT THE STATE OF PA'S EMISSIONS PROFILE, AND PITTSBURGH'S ENERGY CONSUMPTION WE CAN BEGIN TO ESTIMATE THE EMISSIONS FOOTPRINT FOR EACH SECTOR

Pittsburgh energy consumption



Pittsburgh's emissions profile

Residential Carbon Footprint	Commercial Carbon Footprint	Industrial Carbon Footprint
222,641*	**567,517***	**48,020***

*Measured in co2/mmbtu

BUILT ENVIRONMENT ENERGY CONSUMPTION

TOTAL NON-RESIDENTIAL BUILDING FOOTPRINT

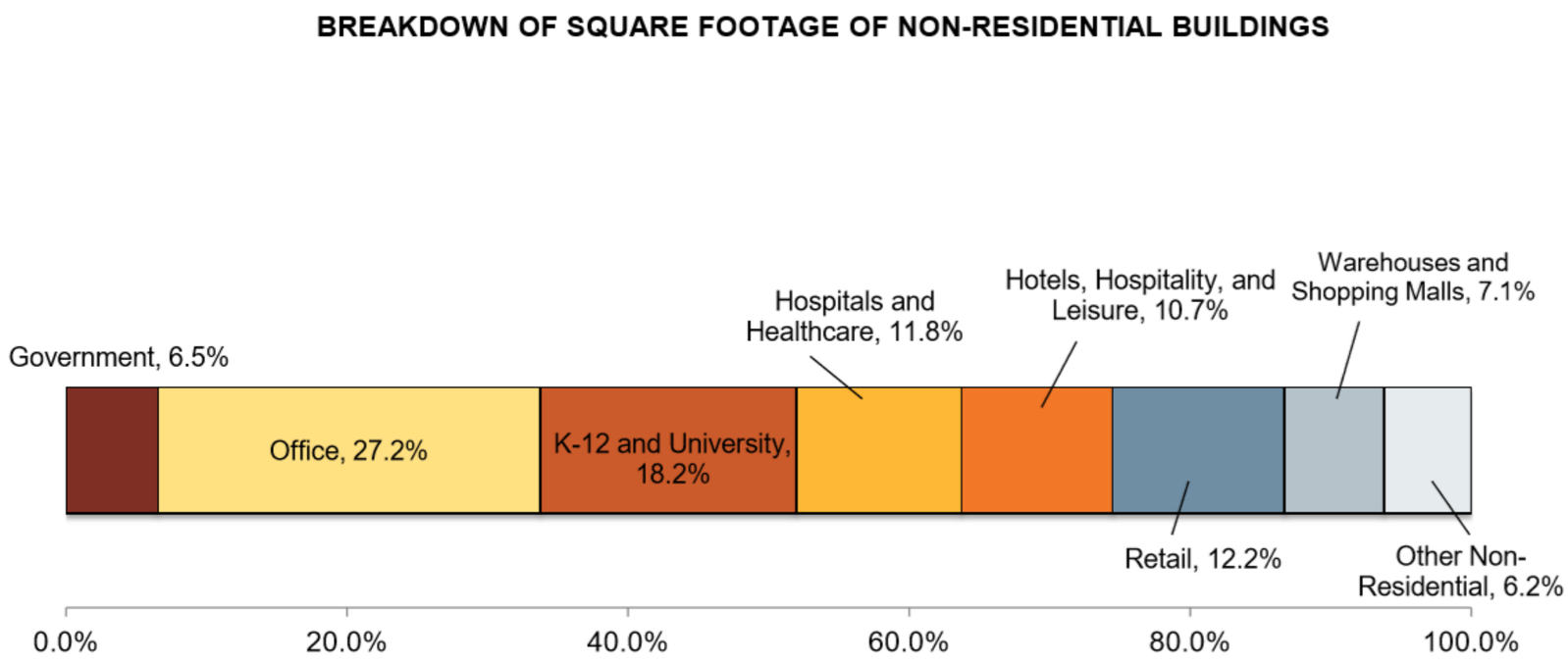
223M ft^2

TOTAL ELECTRICITY CONSUMPTION

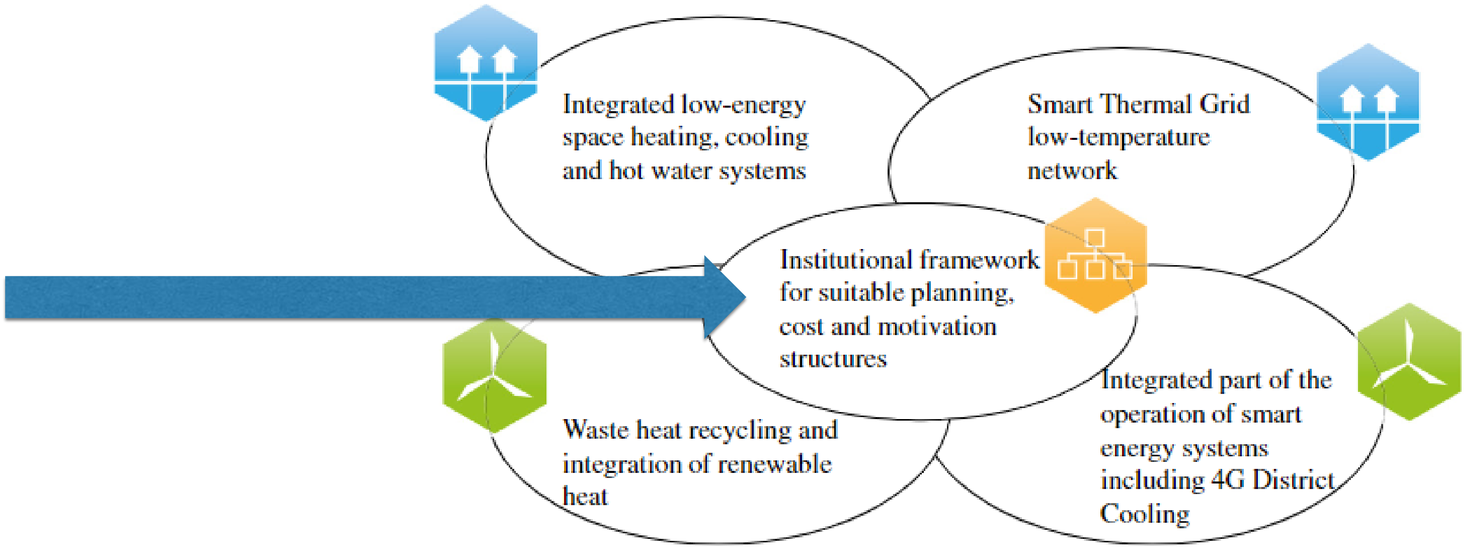
4,147,331 MWh

AVERAGE ENERGY USE INTENSITY

145 $kBtu/ft^2$



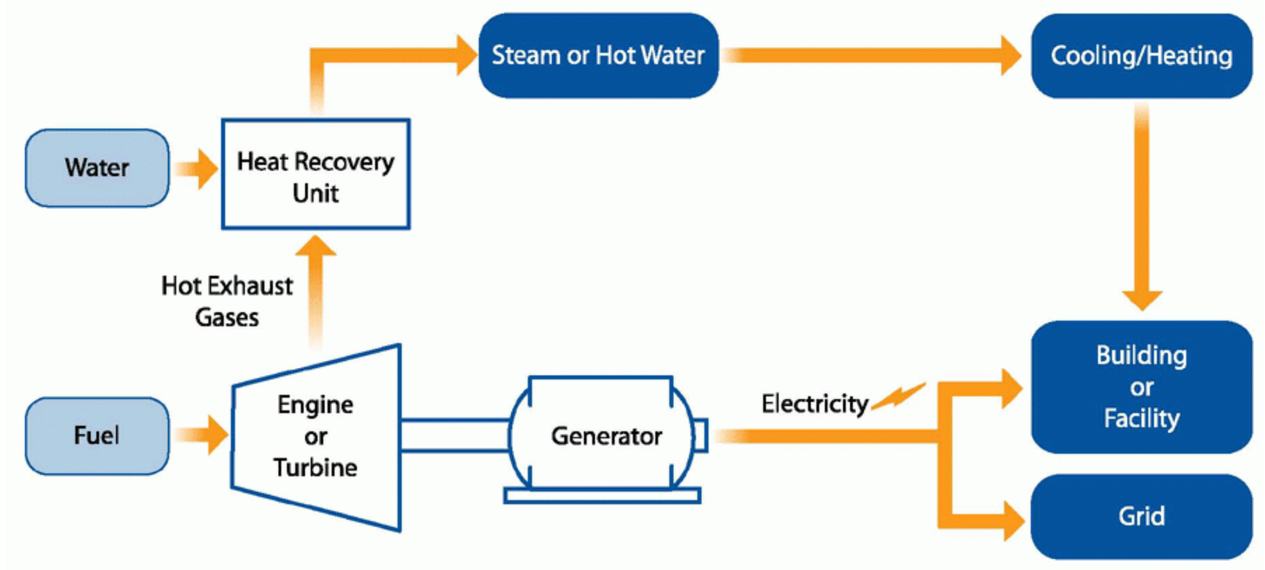
Source:Siemens, 2019

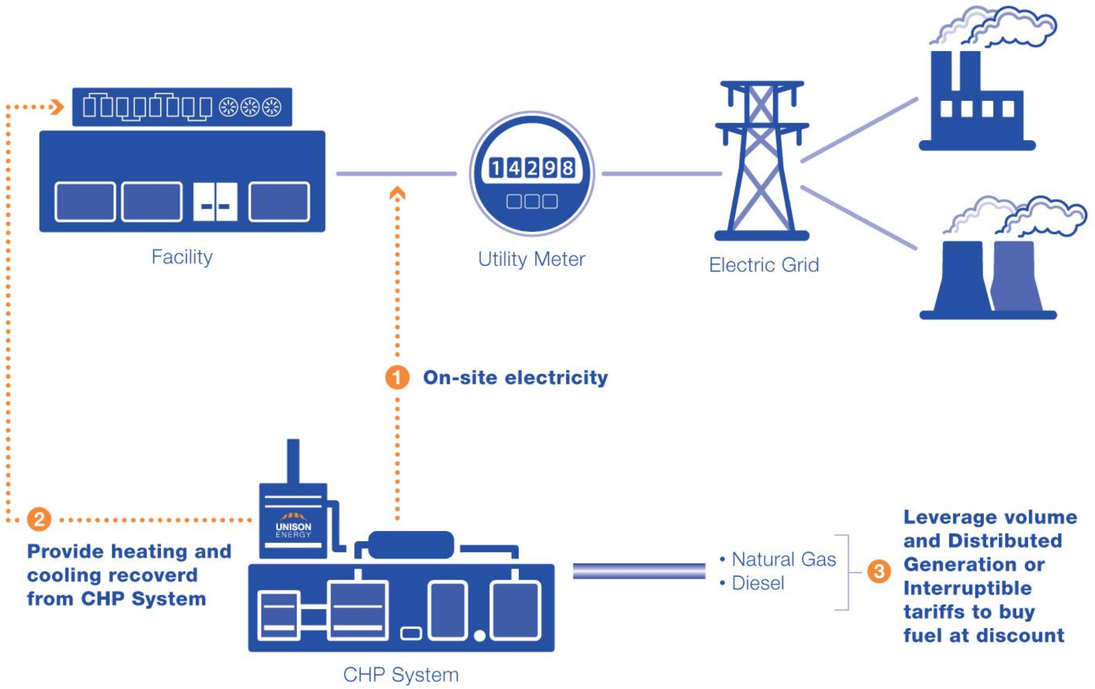


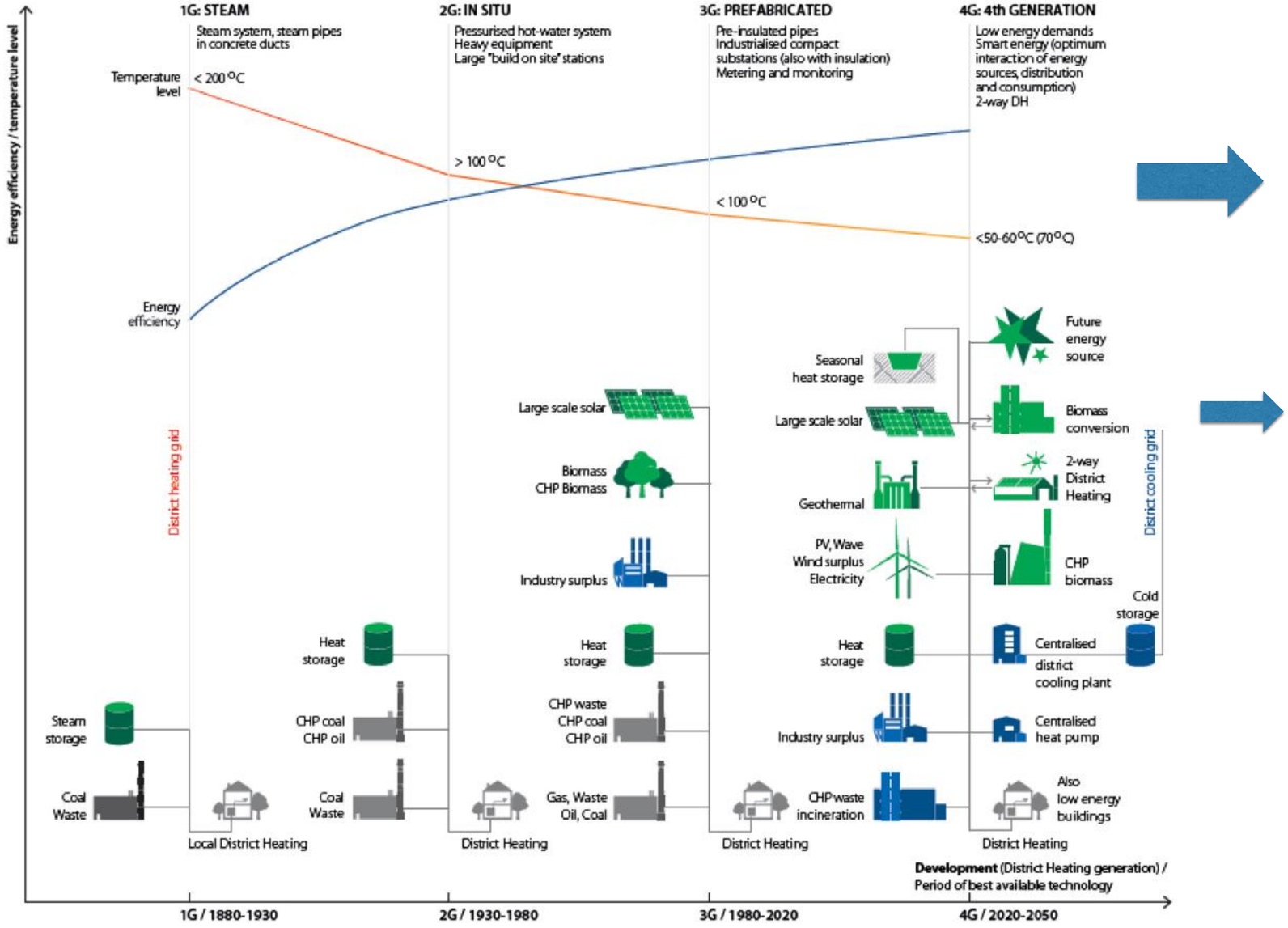
	1st Generation	2nd Generation	3rd Generation	4th Generation
Label	Steam	In situ	Prefabricated	4GDH
Period of best available technology	1880–1930	1930–1980	1980–2020	2020–2050
Production and system integration				
Heat production	Coal steam boilers and some CHP plants	Coal and oil based CHP and some heat-only boilers	Large-scale CHP, distributed CHP, biomass and waste, or fossil fuel boilers	Low-temperature heat recycling and renewable sources
Integration with electricity supply	CHP as heat source	CHP as heat source	CHP as heat source, and some large electric boilers and heat pumps in countries with temporary electricity surpluses. Some very few CHP plants on spot market as exception	CHP systems integrated with heat pumps and operated on regulating and reserve power markets as well as spot markets

Source:Buffa, Simone, Marco Cozzini, Matteo D'Antoni, Marco Baratieri, and Roberto Fedrizzi. "5th generation district heating and cooling systems: A review of existing cases in Europe." *Renewable and Sustainable Energy Reviews* 104 (2019): 504-522.

NOW VS WHERE WE “CAN” GO





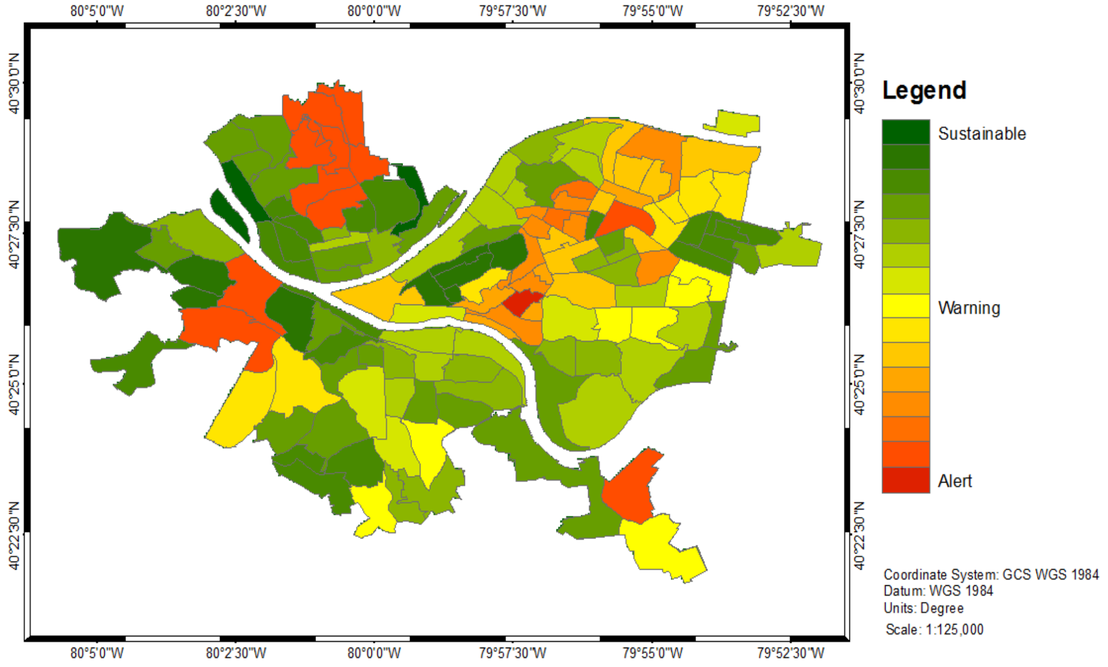


Economic Parameters	
LCOE Discount Rate	4%
Net Tax Factor	1.17
Calculation Rate	4%
VAT	5%
Distortion Loss	20%
Net Price Index	0.70%
Long-Term Loan Rate	4%
Short-Term Loan Rate (debt)	2%
Short-Term Loan Rate (profit)	0%

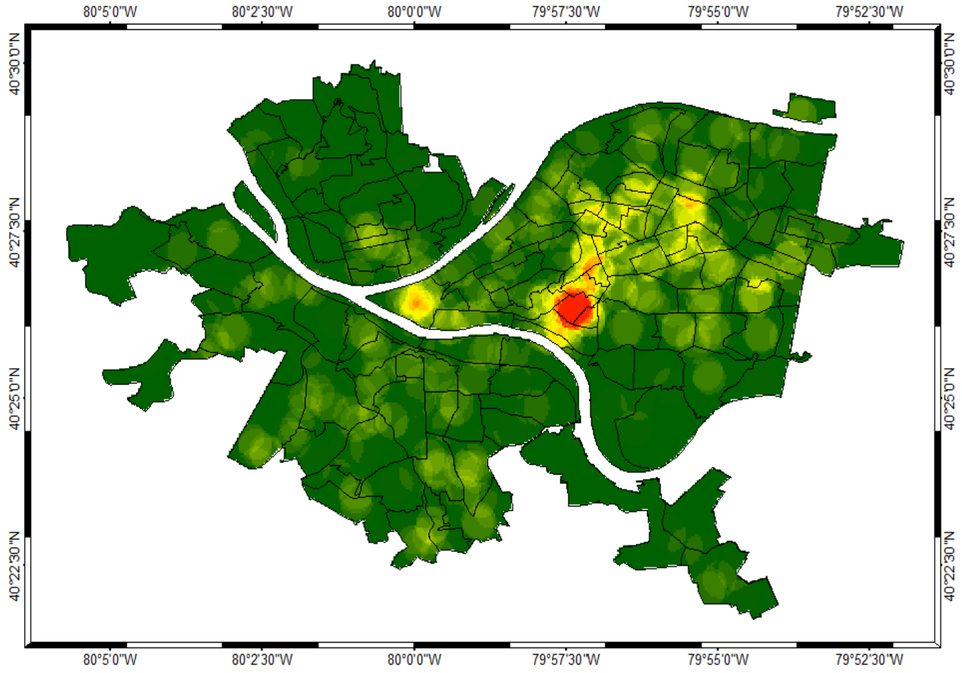
Source:Buffa, Simone, Marco Cozzini, Matteo D'Antoni, Marco Baratieri, and Roberto Fedrizzi. "5th generation district heating and cooling systems: A review of existing cases in Europe." *Renewable and Sustainable Energy Reviews* 104 (2019): 504-522.

UNDERSTANDING ENERGY VULNERABILITY: THE STRESSES TO OAKLAND'S ELECTRICAL SUPPLY

Mapping Vulnerabilities against their probability of occurrence



Identifying "hotspots" of compounding societal, energy, and environmental risks to the City

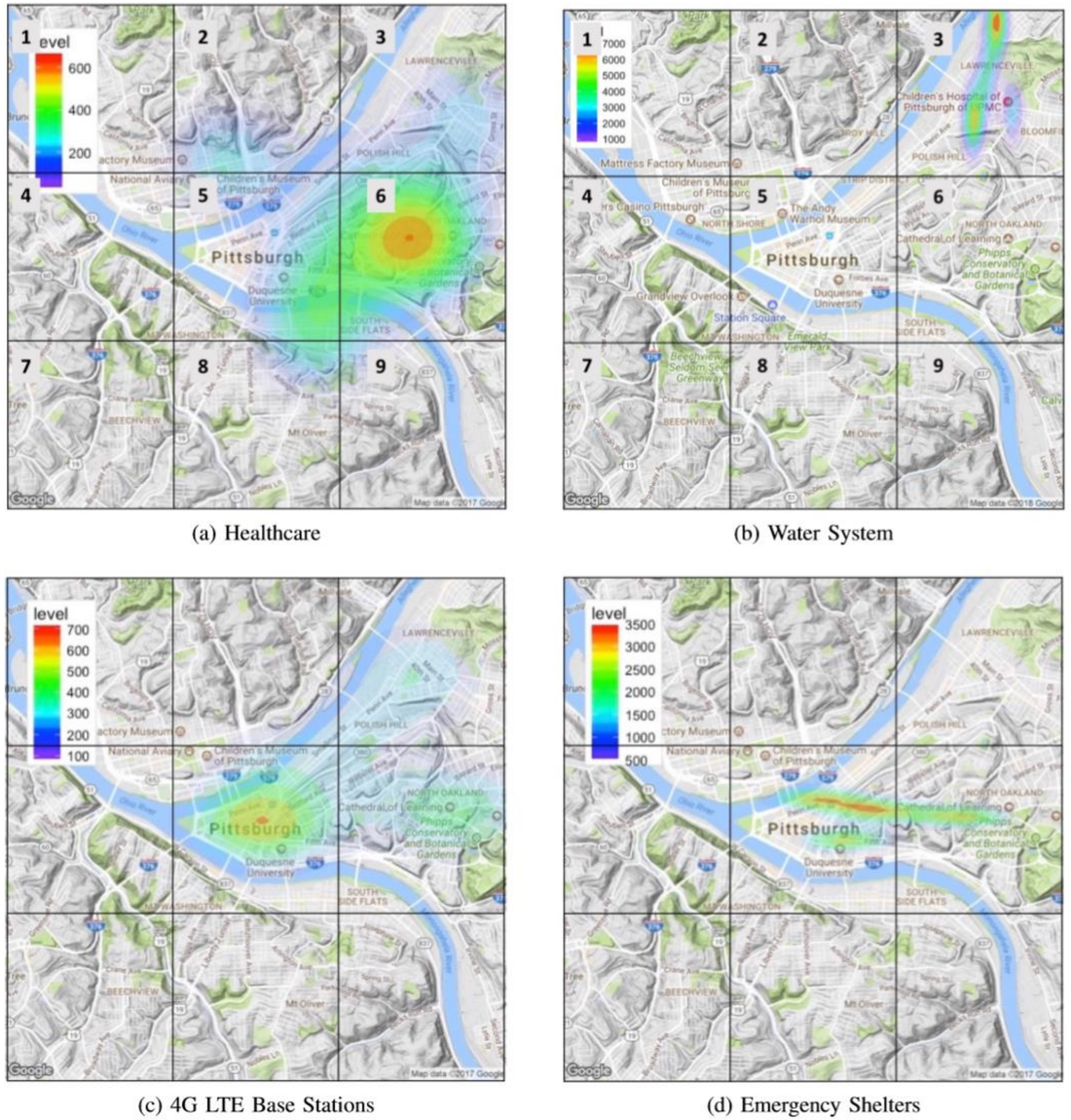


SOURCE: UNIVERSITY OF PITTSBURGH AND US HOMELAND SECURITY, 2017

By mapping environmental and social risks against power outages and heat consumption, Pitt has identified where energy projects need to be prioritized to help improve quality of life: Oakland, the Hill District, the Airport, and Homewood need to be prioritized to remove grid and development vulnerabilities.

WE'VE WORKED TO UNDERSTAND WHERE OUR CRITICAL INFRASTRUCTURE MAPS ON TOP OF ENERGY INFRASTRUCTURES TO SUPPORT THE BROADER DEVELOPMENT OF SMART CRITICAL INFRASTRUCTURE SERVICES

- Not only can we help protect against power outages, but the intention is to create districts within a city that are safe havens with critical services functioning at a degraded but acceptable level of service during a disaster.
- Ensuring that a triad of localized energy solutions are positioned and built in this "socially engineered" manner will help to minimize at-risk neighborhoods, but also help to address the financial justification of microgrids.
- At the same time, when looking at the environmental and energy consumption maps described above, we can see there are clear areas of overlap…..



(a) Healthcare (b) Water System

(c) 4G LTE Base Stations (d) Emergency Shelters

Fig. 4: Critical nodes heat map or each infrastructure

WE CAN THEREFORE SEE FOUR AREAS OF HIGH PRIORITY FOR COMMUNITY ENERGY PROJECTS NEEDED FOR ADAPTATION/RESILIENCE IN THE CITY

These correspond directly to the four main neighborhoods/District Energy solutions proposed above: Downtown; Uptown/Lower Hill; Oakland.

However, transportation is also an issue; where are major corridors where we can address/reduce transportation emissions?

2nd avenue?

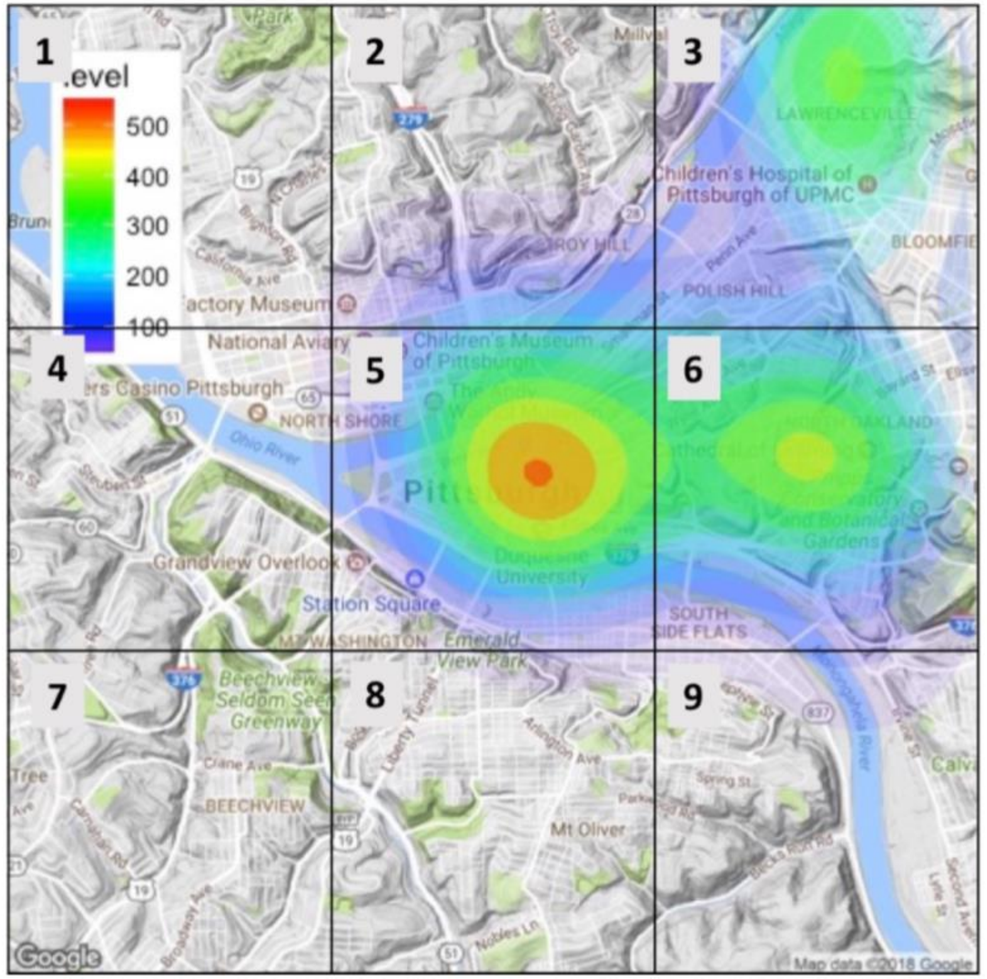


Fig. 5: *Aggregate Heat Map*

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