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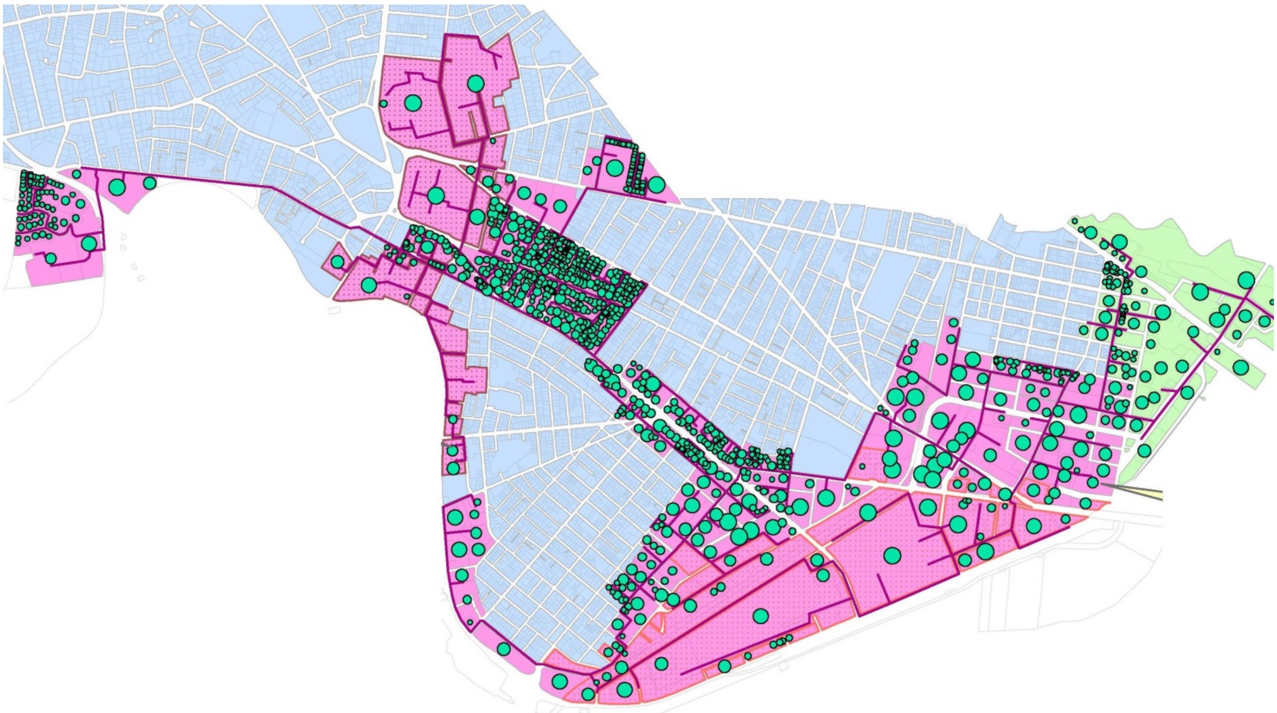
LOW CARBON ENERGY SUPPLY STRATEGY
WP3 RISKS AND BENEFITS



LOW CARBON ENERGY SUPPLY STRATEGY
WP3 RISKS AND BENEFITS

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CONTENTS

APPENDICES

1. INTRODUCTION

Work Package 3 is the Change and Benefit Management section of the project and includes stakeholder engagement, and development of approaches for change and benefit management. The objective of this change and benefit management process is to develop a strategy for securing the required change for the proposed new energy supply.

To identify the changes necessary for successful implementation, the proposed scenario and the solutions it incorporates must be evaluated from a risks perspective. By identifying what the risks are to implementation, a risk mitigation plan which encompasses the change required to realise the proposed scenario is realised. In order to ensure all risks are identified, it is important to take different stakeholder perspectives into account, which is why Stakeholders Engagement is an important aspect of this process.

At this stage in the project, 3 scenarios are shortlisted for technical and economic evaluation under Work Package 4. This Work Package 4 process is on-going in parallel with Work Package 3, and so no single scenario has been selected for the change and benefits management plan to be developed for. As a result this memo outlines the process conducted to date and the initial benefits and risks identified. Following the analysis under Work Package 4 and the resulting recommendations, it will be possible to develop a more scenario specific change management plan which can be used by the City of Cambridge.

2. STAKEHOLDER ENGAGEMENT

At the beginning of the project, Ramboll conducted a Stakeholder Analysis and developed a Communication Plan for the project (see Appendix 2). This analysis identified key stakeholders for the project and how they should be communicated with throughout the project, whether to be engaged with directly, to hold dialogue with, actively communicate with or simply to inform. The Communication Plan for the project, developed on the basis of the Stakeholder Analysis, outlines what, how, when and why identified Stakeholders should be communicated with.

In parallel with this, and in order to ensure strong stakeholder engagement and input, the City of Cambridge established an Advisory Committee for the project. The Advisory Committee role is to review documentation and information provided by the Consultant, and to provide opinion and input to the City based on their different perspectives. The Advisory Committee consists of the below members and has provided for on-going informing, communication and dialogue with the Stakeholders identified in the analysis discussed above. This has provided for strong input from relevant stakeholders throughout the project, facilitating informed shortlisting of the initially identified long list of energy supply scenarios to the current short list of 3.

Table 1 Advisory Committee Members

AC Members	
Harvard, Academic Institution	City of Boston
MIT, Academic Institution	City of Somerville
Eversource, Gas and Electricity Utility	Department of Public Works, Cambridge
Veolia, Heat and Electricity Utility	Electrical Department , Cambridge
CPAC (Climate Protection Action committee)	Planning Department, Cambridge
Compact for a Sustainable Future	Housing Authority, Cambridge
Department of Energy Resources	

Throughout the course of the project 4 Advisory Committee meetings have been held, with a final 5^{th} planned prior to issue of the projects Final Report.

3. IDENTIFYING RISKS AND BENEFITS

In order to identify the risks and benefits associated with the shortlisted scenarios, Ramboll conducted two workshops, one with the City of Cambridge inclusive of the Dept. of Public Works, and one with the Advisory Committee.

The workshop process facilitated further evaluation and discussion of the shortlisted scenarios amongst the stakeholders, bringing further understanding of the City's ambition to all participants. Additionally the workshops allowed for real stakeholder risks and issues to be identified for resolution as the selected scenario is progressed.

3.1 Workshop 1: June 27th, 2017

This workshop was conducted via video conference and was attended by the following participants:

- City of Cambridge Planning Dept.: Seth Federspiel, Susanne Rasmussen, Bronwyn Cooke
- City of Cambridge, Dept. of Public Works: Owen O'Riordan, Ellen Katz
- Ramboll: Isidore McCormack, Mairead Kennedy

This was a short duration workshop to go through the risk and benefit identification process further with the City and to prepare for the main workshop with the Advisory Committee.

The Benefits and Risks identified during this workshop are included in Appendix 3.

3.2 Workshop 2: July 19th, 2017

This workshop was conducted in the City Hall Annex and was attended by the Advisory Committee and City of Cambridge representatives.

The agenda was as follows and the related slides are included in Appendix 4.

1. Presentation of energy needs and the challenges faced by the City of Cambridge
2. Examples of peer city pathways to carbon neutrality
3. Overview of shortlisted scenarios
4. Break into groups for benefit mapping
5. Discuss benefits identified per scenario
6. Break into groups for risk mapping
7. Discuss risks identified per scenario
8. Review next steps

The teams for the group work were as per the table below.

Table 2 Group Work teams

Scenario 1 Team	Scenario 2 Team	Scenario 4 Team A (biomass)	Scenario 4 Team B (WTE)
Adam Hasz	Seth Federspiel	Susanne Rasmussen	Ellen Katz
Melissa Chan	Samantha Meserve	Adam Jacobs	Steve Lanou
John Bolduc	John Cleveland	Mary Smith	Melissa Peters
		Patrick Haswell	

To identify the project benefits, the teams were asked to consider their assigned scenarios and the benefits this scenario posed for the City of Cambridge in relation to the below goals of the City for their future energy supply.

- **Clean**: Reduce carbon emissions and toxic pollutants created by the system.
- **Reliable**: Minimize system downtime from outages and ensure high quality of power delivered.
- **Affordable**: Keep rates as low as possible and maintain competitiveness.
- **Predictable**: Minimize rate volatility.
- **Transparent**: Consumers can understand their power costs and what drives changes in costs.
- **Local Control**: Give residents greater control over their energy resources and energy choices.
- **Wealth Creating**: Keep more energy revenue in the local economy instead of exporting it to outside suppliers — to help drive local economic development, create new businesses and jobs.
- **Innovative**: The system spawns innovation, intellectual property creation, and entrepreneurship.
- **Just**: The system promotes "energy equity," protecting vulnerable populations from undue hardship, and promotes energy literacy.

Benefits were written down by the team on "post-its" and posted to the poster template provided as shown in Figure 2 below.

Following the collaboration period, each team presented their discussion on the benefits they determined.

Multiple benefits were identified for each scenario. Significant benefits identified during the City workshop and the AC workshops are highlighted below in Section 4.

Figure 1 Scenario 4 WtE Team Consider Scenario Benefits

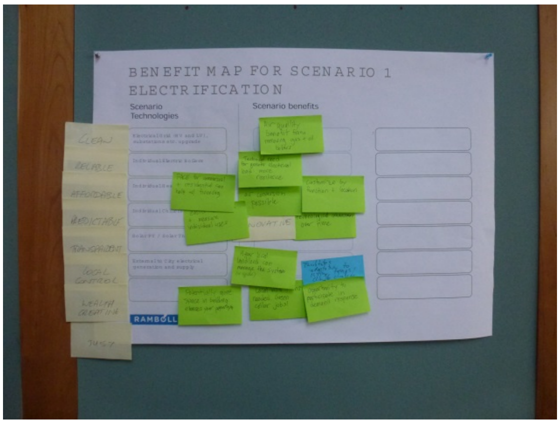


Figure 2 Scenario 1 Benefits Identified

Following this group process, the team consider the Risks associated with implementing each respective scenario proposed. As discussed above, by identifying what the risks are to implementation, a risk mitigation plan which encompasses the change required to realise the proposed scenario can be realised. The risks of significant interest from the City workshop and the AC workshops are highlighted below in Section 5.

Collaboration and involvement was excellent throughout the workshop and demonstrated strong understanding of the Scenarios proposed and willingness to progress the project process for a successful conclusion.

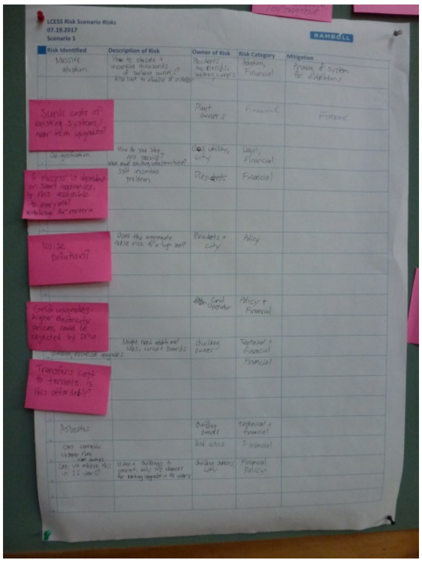


Figure 3 Scenario 1 Risks Identified

Figure 4 Scenario 2 and Scenario 4 Risks Considered by teams

4. BENEFITS IDENTIFIED

Significant benefits identified during the City workshop and the AC workshops are highlighted below per Scenario.

Scenario 1

- No need for new connections – everyone is connected.
- Positive impact on electrifying transport
- No need for siting of new plant
- Electrical Framework is in place
- Air quality improvement in City as oil and gas boilers removed
- Easy phasing – building by building conversion
- State rate payers share grid reinforcement requirements
- Provides opportunity for improved Grid Resilience as network is invested in
- Larger single energy market will push innovation
- Local installations needed which creates green collar jobs

Scenario 2

- Air quality improvement in City as oil and gas boilers removed
- Improved resilience as thermal and electrical demands met by split supply
- Opportunity for energy storage; ATES, Battery if affordable Multiple media (air, ground, water) options for central heat pumps
- Thermal storage can help address volatility of grid prices and mitigate peak demands

Scenario 4

- Thermal storage is a possibility and can be sued to store spill electricity supply
- Increased reliability of City's power supply
- Increased control and resilience regarding energy price fluctuation
- Fuel flexibility capability whilst not impacting consumers
- Supply and generation control within City, providing for wealth creation
- Potential to allow the City have more control over transparency and justness
- Potential for increased transparency for energy pricing
- Facilitates use of lower temperature heat sources
- Good transition – District Energy is known technology in Cambridge – can use existing infrastructure

- WtE: Local accountability for City's waste
- WtE: Utilizing all waste and energy sources available in Cambridge
- Biomass: Clean-ish
- Biomass: Wealth creating

5. RISKS IDENTIFIED

The risks of significant interest from the City workshop and the AC workshops are highlighted below per Scenario.

Scenario 1

- Electrical Company cooperation: Grid modernisation out of City control - Eversource may not be prepared to upgrade for this path forward
- Electrical Company cooperation: Investment in Cambridge only may be difficult for Company to justify
- Power failure: Not resilient infrastructure as all above ground
- Control over low carbon supply: Limited control on how green imported electricity is
- Consumer compliance with implementation: Building may not convert to electric
- Stranded assets: Gas infrastructure not at end of design life / commercial payback, Electrical infrastructure not utilised
- Cost Risk: Competitive with gas?
- Degasification: How to stop existing service and address existing infrastructure issue?
- Degasification: Gas currently cheaper than heat pumps
- Noise pollution: Does the aggregate noise of Air Pumps rise to an unacceptable level for the City?
- Increased electricity prices: Grid upgrades will result in higher electricity prices which could be rejected by DPU
- Building electricity upgrades: Might need additional lines, circuit boards

Scenario 2

- Infrastructure upgrades: Financial impact
- Infrastructure upgrades: Implementing upgrades
- Infrastructure upgrades: Getting stakeholder buy in for these
- Degasification: Utility opposition
- Grid capacity: Significantly increased load will need to be addressed
- Reliability: Grid black/brown out will impact significantly - no increase in reliability

Scenario 4

- Lack of regulation: Hot Water DH not currently regulated in MA
- Residential Heat Pumps: Grid reinforcement may be required in residential areas
- Establishment of DHC network: physical impact and lack of space in road
- Transferring consumers to DHC: Getting buildings to connect to the network
- Siting generation plants in Cambridge – limited space and likely opposition
- First adopter risk: Is scenario compatible with regional efforts to reduce carbon intensity of energy supply?
- Degasification: Existing gas infrastructure becoming a stranded asset
- Legal: Permitting, ownership, policy and operation of new plants
- WtE: Limited Municipal Solid Waste availability – City to import waste?
- WtE: Local emissions, nuisance
- WtE: Does City have authority to implement?
- Biomass: Lack of Biomass supply-Sustainable supply chain not existent
- Biomass: Supply, resilience, transport and delivery
- Biomass: Environmental risk; Is biomass net carbon free?

APPENDIX 1
SHORTLISTED SCENARIO

Scenario 1 – Individual Electricfication

Technologies

This scenario consists of building level electrification of thermal energy and cooling demand for the whole City and building types.

The only heat production technology considered as part of this scenario is a heat pump utilizing a low grade heat source, which is upgraded to building operating temperatures by use of electricity. The cooling technologies are individual chillers and air-conditioning facilities, also supplied by electricity.

The electricity supply will be dependent on external supply of renewable electricity through greening of New England Power Pool (NEPOOL), RECs and/or through investing in a renewable installation outside the city border. Maximum deployment of solar PV within the city boundary is assumed.

Electricity is supplied by the external electricity grid with production from both conventional- and renewable power stations. Electrical consumption will increase with the introduction of electrically driven heat pumps and chillers as a replacement for gas furnaces. Cambridge city can invest in wind turbines located outside the city, buy green certificates or invest in solar PV mounted on rooftops inside the city. Whilst NEPOOL is expected to increase the proportion of renewable and sustainable power generation it is not expected to achieve 100 zero carbon over the timeframe of the study. The scale of the increase in electricity demand will likely reduce the potential for achieving full de-carbonization of electricity supply, especially in the medium term due to limited renewable energy capacity.

The increased electrical load associated with the introduction of electrically driven heat pumps will require additional capacity or even new substations within the area to meet the increased demand. Reinforcement of the electrical grid will also be a requirement with the widespread introduction of electrically driven heat pump solutions within the area. The transformation away from natural gas will also leave the existing gas network redundant.

Individual heat pumps are expensive but also very efficient. The cons are that they will need supplemental heat sources (air, water, ground), which should be included in the capital costs. The investment costs for electric boilers are much lower, but the efficiency is much lower compared to heat pumps.

The viability of a heat pump solution is very much dependent on the availability of abundant low cost electricity. The price of electricity consists of different components e.g. the costs from the power exchange, transportation costs (transmission and distribution), capacity cost, any fees etc. An individual solution will most probably pay quite a high price for the electricity since a smaller heat pump will be connected at a lower voltage level with higher distribution costs. With a heat pump connected centrally it could be connected at a higher voltage level with lower distribution costs. Furthermore, storage options will be limited with individual solutions. Therefore, it will be necessary to have the heat pump in operation even during times of high electricity pricing from the power exchange if there is a demand for heat, and this can often coincide with energy supplied at the highest carbon intensity.

An electrified solution provides limited resiliency for Cambridge and exposes residents to the potential for losing both heat and power in extreme weather events. Battery storage is a very expensive solution to overcome this issue at the moment and the technology is far from achieving the economic level required to compete with power plants.

Heat pump technology on an individual building basis has limited potential for storage to take account of fluctuating electricity supply from renewable energy sources, which result in the need for demand side management on a city wide scale. For this to work, electrification of the energy system will need to be combined with a wide scale roll out of “smart” appliances. Still, the economic benefit of flexible operation from individual heat pumps is much higher for the system than for each consumer. Therefore, an incentive tariff for flexible operation is required to encourage individual consumers.[1]

Figure 5-1below outlines a visual representation of the technologies involved under this scenario.

[1] Absorption heat pumps are also an option, but not considered since they do not use excess electricity production from renewables

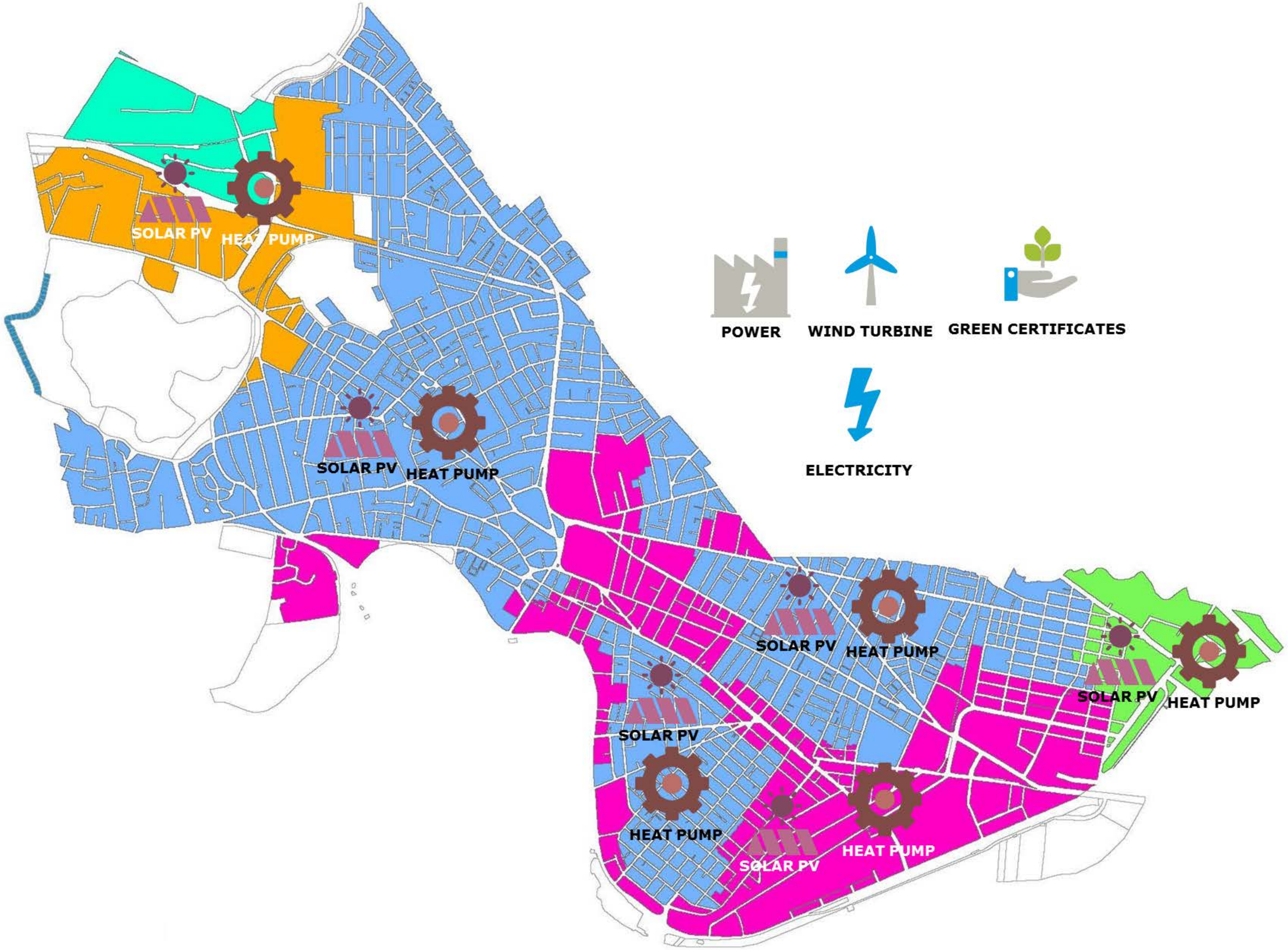


Figure 5-1 Visual representation of Scenario 1

Scenario 2 – District energy electrification

Technologies

This scenario is a further development of scenario 1. In this scenario, the buildings in zone 1 and eventually zone 3 and zone 4 will be supplied by a district heating and cooling (DH&C) system which is electrically supplied by heat pumps, electric boilers and chillers – all with thermal storage included. Zone 2, the low density areas will be primarily be supplied through individual heat pumps, solar PV and chillers.

The city will still be dependent on supply of low carbon electricity from the external electricity grid. The greening of New England Power Pool (NEPOOL), RECs and/or investments in renewable installations outside the city border is required. Maximum deployment of solar PV within the city boundary is assumed. Figure 5-2 displays the overall structure of scenario 2. Electricity is supplied by the external electricity grid with production from both conventional- and renewable power stations. Electrical consumption will increase with the introduction of electrically driven heat pumps and chillers as a replacement for gas furnaces.

Cambridge City can invest in wind turbines located outside the city, buy green certificates or invest in solar PV mounted on rooftops inside the city. Whilst NEPOOL is expected to increase the proportion of renewable and sustainable power generation it is not expected to achieve 100 percent zero carbon over the timeframe of the study. The scale of the increase in electricity demand will likely reduce the potential for achieving full de-carbonization, especially in the medium term due to limited renewable energy capacity. The smaller buildings will still be supplied by individual heat pumps, but the larger buildings with a higher heat density will be supplied from centralized DH&C systems.

It should be stressed that the flexibility and resiliency of this scenario is very limited. In case of failure in the electrical grid there will be no back-up technology for the production of heat. A way to address this would be to have very large emergency generators running on natural gas or oil. A way of increasing resilience would be to have oil based emergency back-up to take into account failure in the natural gas system as well. The emergency generator will most likely have very limited hours in operation per year. Therefore, the consumption of fossil fuels would be insignificant.

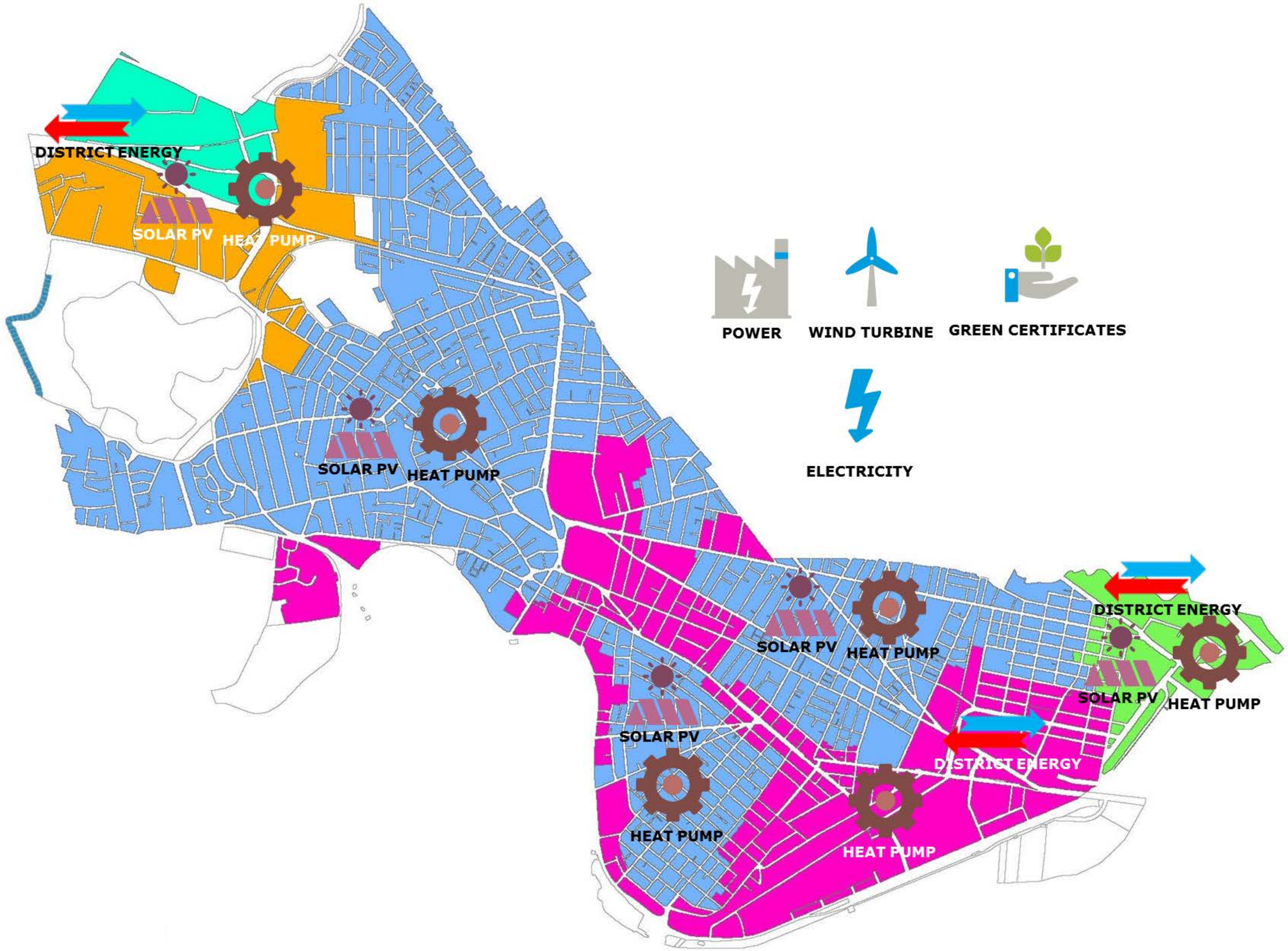


Figure 5-2 Visual representation of Scenario 2

Scenario 4 – District Heating & Cooling systems

Technologies

This scenario consists of providing district heating and cooling (DH&C) to most of the city where heat density makes it viable. Heat pumps, biomass combined heat and power plants and waste-to-energy plants are being considered for delivery of district heating. The heat pumps will also work alongside chillers to provide district cooling.

Thermal storage will be used for both district heating and cooling scenarios. An ATES (Aquifer Thermal Energy Storage) system is also included in the scenario to utilize the synergies between district heating and cooling systems. Electric boilers are a cheap solution for producing heat based on excess renewable electricity production in this scenario.

Where heat pumps are being used in these scenarios it is assumed that they will utilize the most beneficial and available heat source for their application. This could be the Charles River, waste heat from sewers etc.

The district cooling system will be constructed in clusters of high cooling density supplied by heat pumps using an ATES system and chillers. The electricity consumption can be supplied as outlined under Scenario 1, supplemented by biomass CHP or waste-to-energy plants which will also produce electricity. Solar PV mounted on each building is still an option for increased local electricity production. The scenario is visually represented in Figure 5-3. Locations of infographics in the figures are only to indicate supply technologies proposed for each zone, and do not take into account existing plant and are not representative of actual locations.

Local solar PV production mounted on rooftops is included. The electrical network may need strengthening and the economic costs may be too high, but the idea is not excluded.

Within this scenario is the potential to generate heat and power from alternative fuel sources, such as biomass and waste. The below are first indications of the potential supply such plants could provide to the City.

Biomass Combined Heat and Power

Based on the load curve developed for Zone 1, the initial sizing of a Biomass CHP estimated will supply approx. 250,000MWh, which is 20% of the total electricity demand of the City per year.

Waste to Energy

The quantity of waste being generated in the City was assessed to determine the size of facility that could be supported in the City. A 10MW (34mmBTU/hr) heat generating Waste to Energy facility would be fuelled by 50,000 tons of waste. This is over twice the current trash tonnage managed by the City. This would additionally provide 2MW of electricity generation which is equivalent to 1% of the total electricity demand of the City.

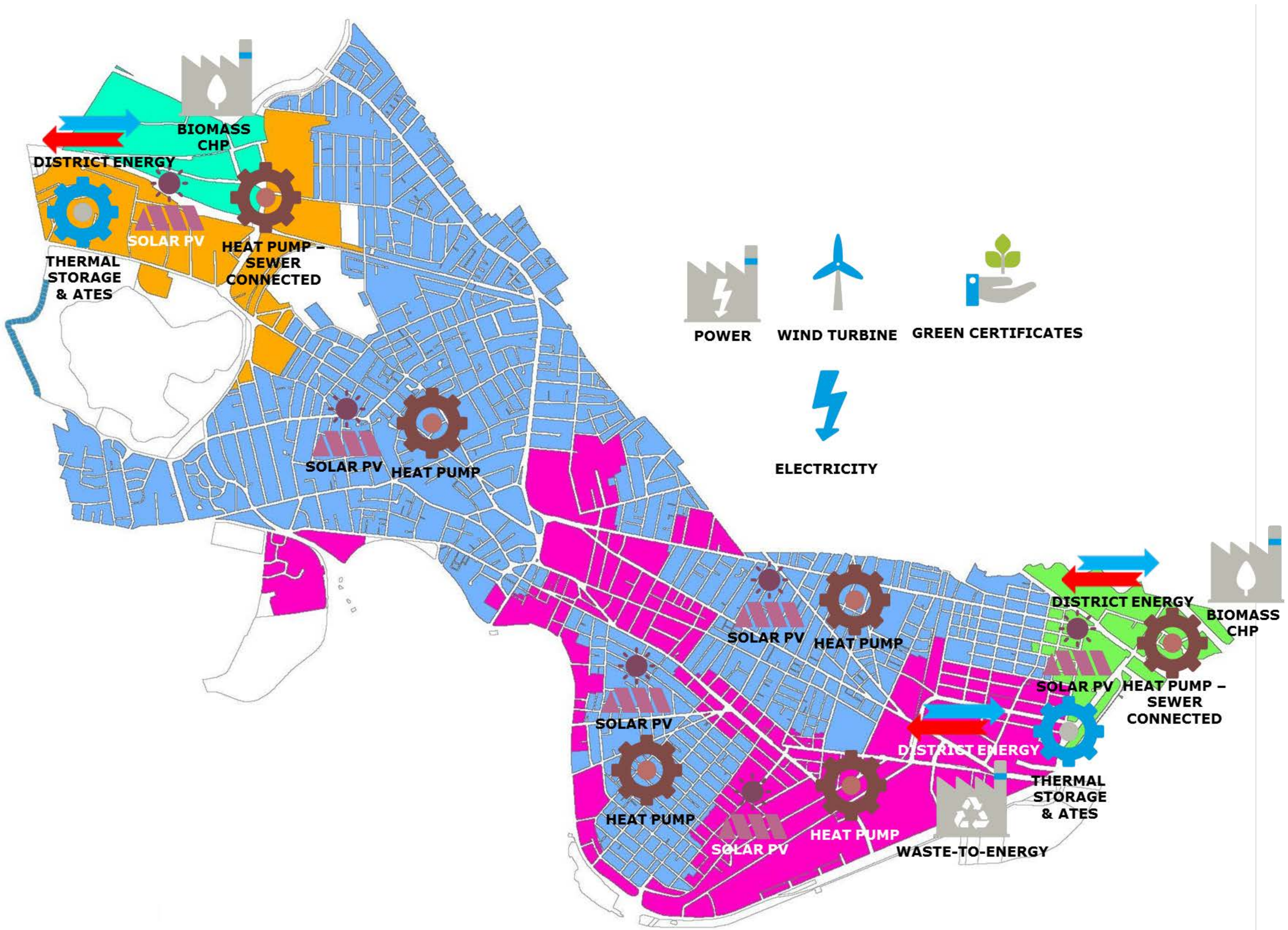
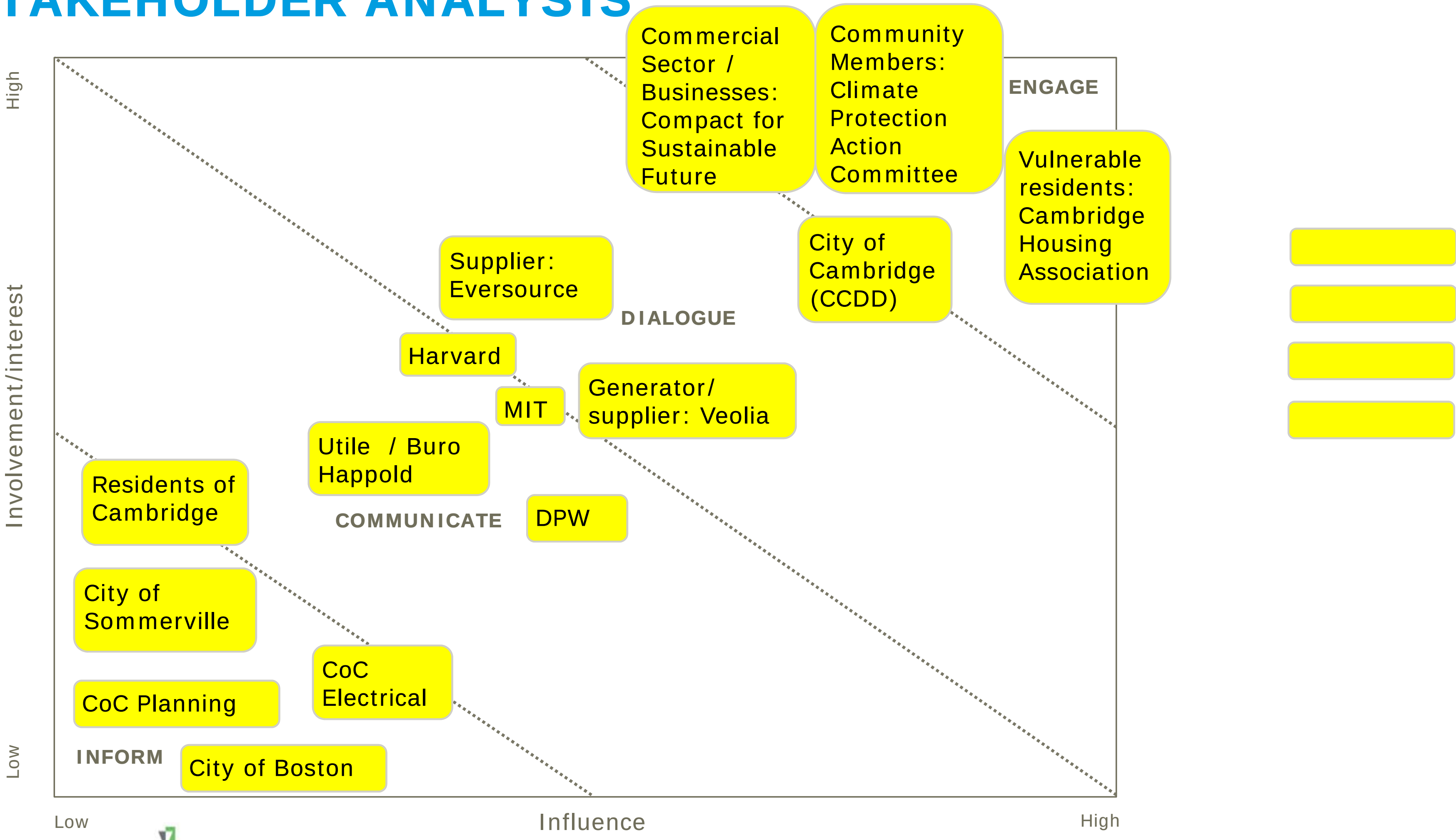


Figure 5-3 Visual representation of Scenario 4 Options

APPENDIX 2
STAKEHOLDER ANALYSIS AND COMMUNICATION PLAN

LCESS STAKEHOLDER ANALYSIS



COMMUNICATION PLAN

WHOM	WHAT	HOW	WHEN	WHY	RESPONSIBLE
CCDD	Inform on project progress. Red flag any issues foreseen which impact budget or delivery	Bi-weekly calls Ad-hoc calls and emails. Decision gate meetings	Bi-weekly as agreed, with further communication as required.	Ensure good relationship with client.	Ramboll, RGV
Generator / supplier: Veolia	Requests for information Project benefits	Email via CCDD / Ramboll / RGV Face to face meeting	From now until next AC meeting	Gather data and identify barriers to project goals. Gain comment on scenarios developed.	CCDD currently. Suggest direct contact via RGV agreed. CCDD to provide introduction email.
Supplier: Eversource	Requests for information Project benefits	Email via CCDD / Ramboll / RGV Face to face meeting	From now until next AC meeting	Gather data and identify barriers to project goals. Gain comment on scenarios developed.	CCDD currently. Suggest direct contact via RGV agreed. CCDD to provide introduction email.
Commercial Sector / Businesses: Compact for Sustainable Future	Scenarios identified Project benefits	Emails and face to face meeting to explain proposed scenarios.	End February before submission of scenarios to AC	Get buy in: CSP represent many influential businesses in Cambridge – their demands will change suppliers performance	CCDD Ramboll
Vulnerable residents: Cambridge Housing Association	Scenarios identified Project benefits	Emails and face to face meeting to explain proposed scenarios.	End February before submission of scenarios to AC	Get buy in: CHA deal with 10% of energy consumers of Cambridge. Give comment on practical barriers for the 10%. Influential body with regard to supply changes required due to the 10% they support	CCDD Ramboll

COMMUNICATION PLAN

WHOM	WHAT	HOW	WHEN	WHY	RESPONSIBLE
Community Members: Climate Protection Action Committee	Scenarios identified Project benefits	Emails and face to face meeting to explain proposed scenarios.	End February before submission of scenarios to AC	Get buy in: Provide recommendations to Mayor for action	CCDD Ramboll
MIT	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans, receive comment.	CCDD Ramboll
Harvard	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans, receive comment.	CCDD Ramboll
City of Sommerville	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans, receive comment.	CCDD Ramboll
City of Boston	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans, receive comment.	CCDD Ramboll
CoC Planning	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans	CCDD Ramboll
CoC Electrical	Scenarios identified Project benefits	AC Meetings	As per project plan	Better coordination with their plans	CCDD Ramboll
DPW	Requests for information Scenarios identified Project benefits	Email via CCDD / Ramboll / RGV Face to face meeting AC Meetings	From now until next AC meeting As per project plan	Gather existing utility data. Better coordination with their plans	CCDD, RGV, Ramboll
Utile Architects / Buro Happold – Envision Cambridge	Scenarios identified	Emails / VC presentation to explain proposed scenarios.	End February before submission of scenarios to AC	Better coordination with their plans. Discuss tie ins.	CCDD, RGV. Ramboll

COMMUNICATION PLAN

WHOM	WHAT	HOW	WHEN	WHY	RESPONSIBLE
Residents of Cambridge	Establish need for change of energy supply	Bus and bike shelters posters	Ongoing when possible	Inform and educate of action	CCDD Ramboll provide text as requested
	Establish need for change of energy supply	Website and social media	Ongoing when possible		CCDD
	Establish need for change of energy supply	Quarterly Newsletter to households	Quarterly		CCDD Ramboll provide text as requested
	Establish need for change of energy supply	Tactical urbanism – stickers on lamppost or other	Ongoing when possible		CCDD
	Establish need for change of energy supply	Stands at CCDD attended events	When possible		CCDD
	Establish need for change of energy supply	Public engagement Presentation	Feb / March, 2017		Ramboll
	Transition process proposed Project benefits	Earth Day (week) Booklet	April, 2017		CCDD Ramboll provide text as requested
	Transition process proposed Project benefits	Earth Day (week) Presentation	April, 2017		Ramboll
	Transition process proposed Project benefits	Public engagement Presentation	Sept., 2017		Ramboll
	Transition process proposed Project benefits	Greenbuild, Boston Presentation	Proposals due 1/13/17 Presented 11.8-10.2017		CCDD, Ramboll & RGV

APPENDIX 3
BENEFITS AND RISKS IDENTIIED BY CITY OF CAMBRIDGE

ENERGY

MINUTES OF MEETING

Project	**LCESS**
Subject	**Work Package 3: Benefits and Risks Identification**
Date	**06/27/2017**
Location	**City of Cambridge, City Hall Annex**
Taken by	**Isidore McCormack**
Participants	**Seth Federspiel, Susanne Rasmussen, Owen O'Riordan, Ellen Katz, Bronwyn Cooke (City of Cambridge), Isidore McCormack, Mairead Kennedy (Ramboll)**
Absent	**Michael Orr, Steve Lenkauskas**

Date 13/07/2017

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1. Introduction

The objective of this meeting was to assess the benefits and risks of the 3 shortlisted scenarios for the LCESS in advance of the AC meeting in July.

The following pages outline the benefits and risks identified during this meeting.

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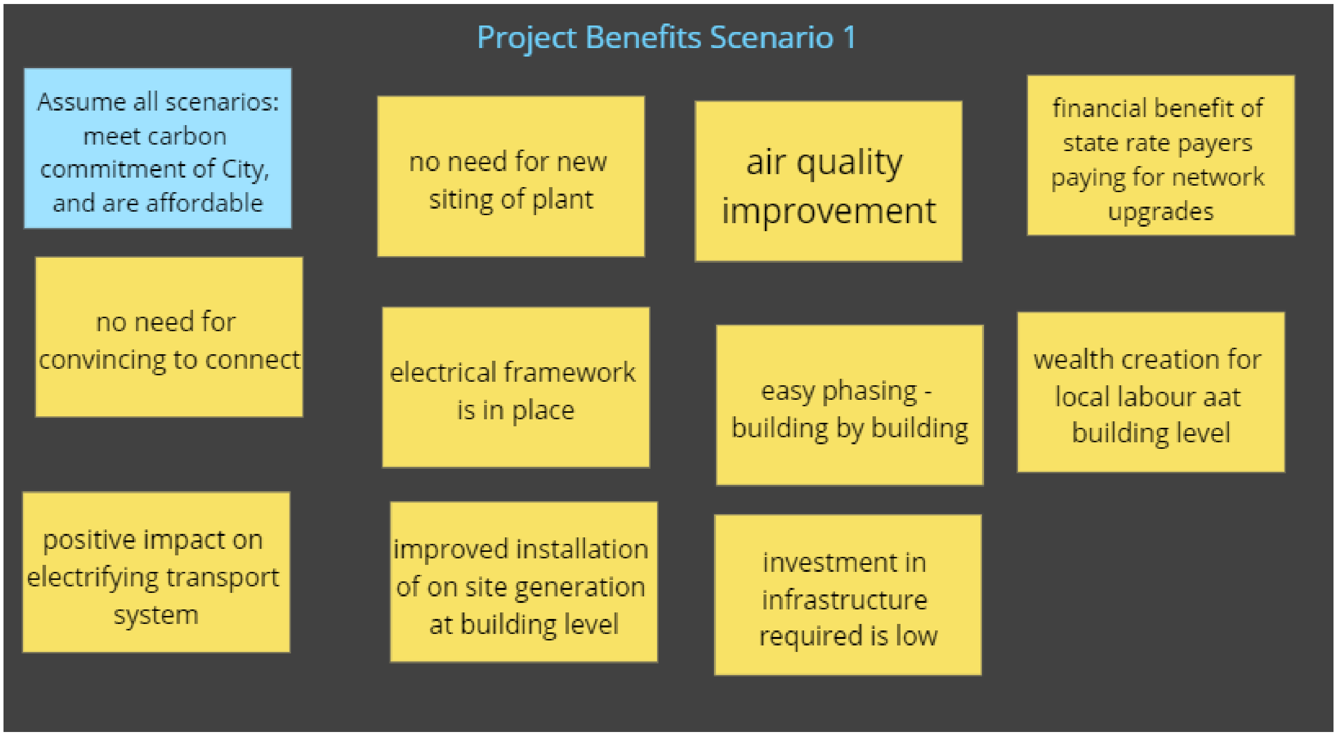


Figure 1 Scenario 1 Benefits

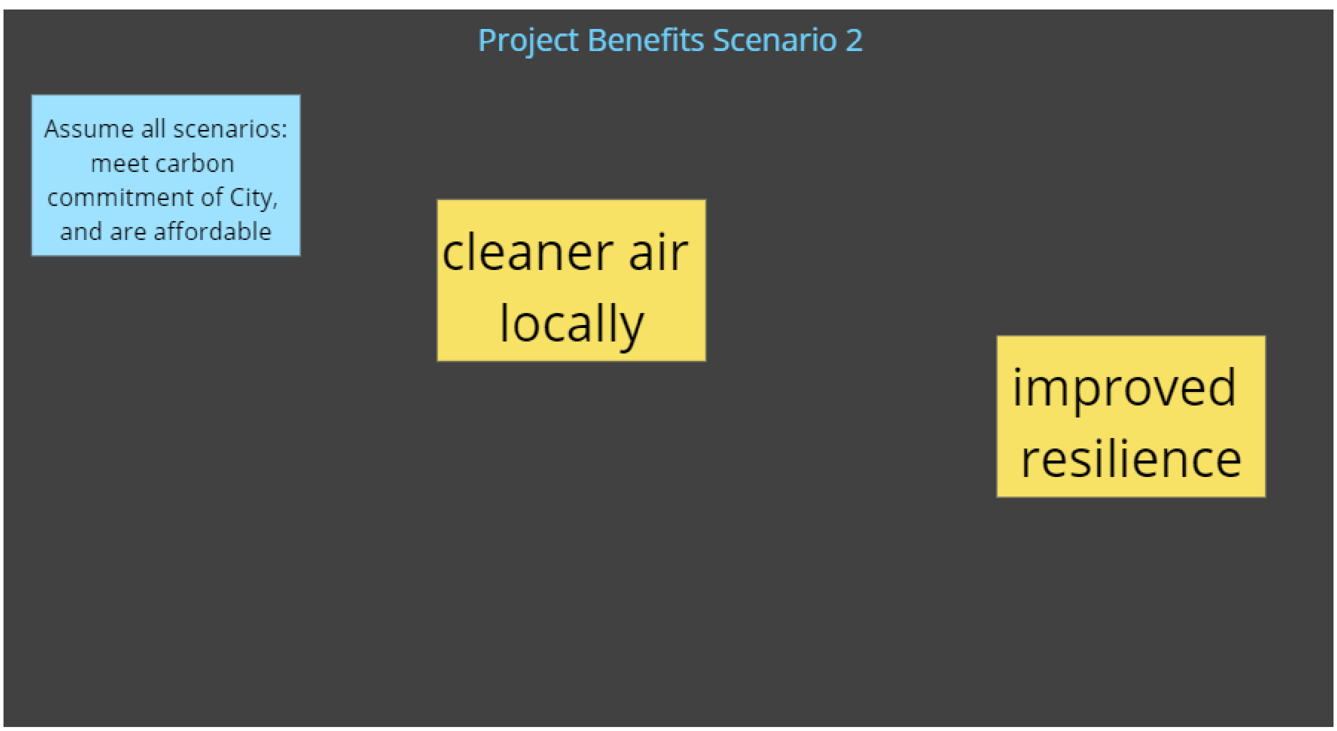


Figure 2 Scenario 2 Benefits

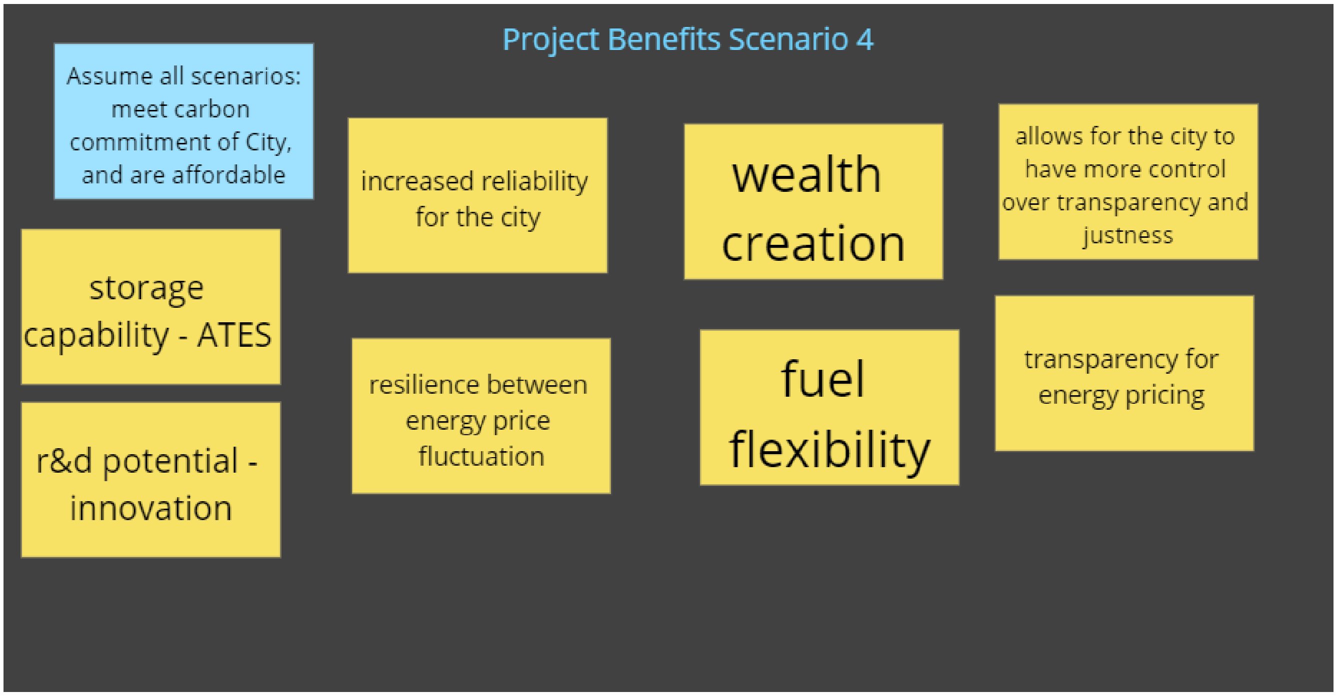


Figure 3 Scenario 4 Benefits

LCESS Risk Scenario Risks
06.27.2017
Scenario 4

What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.

Risk Categories to Consider

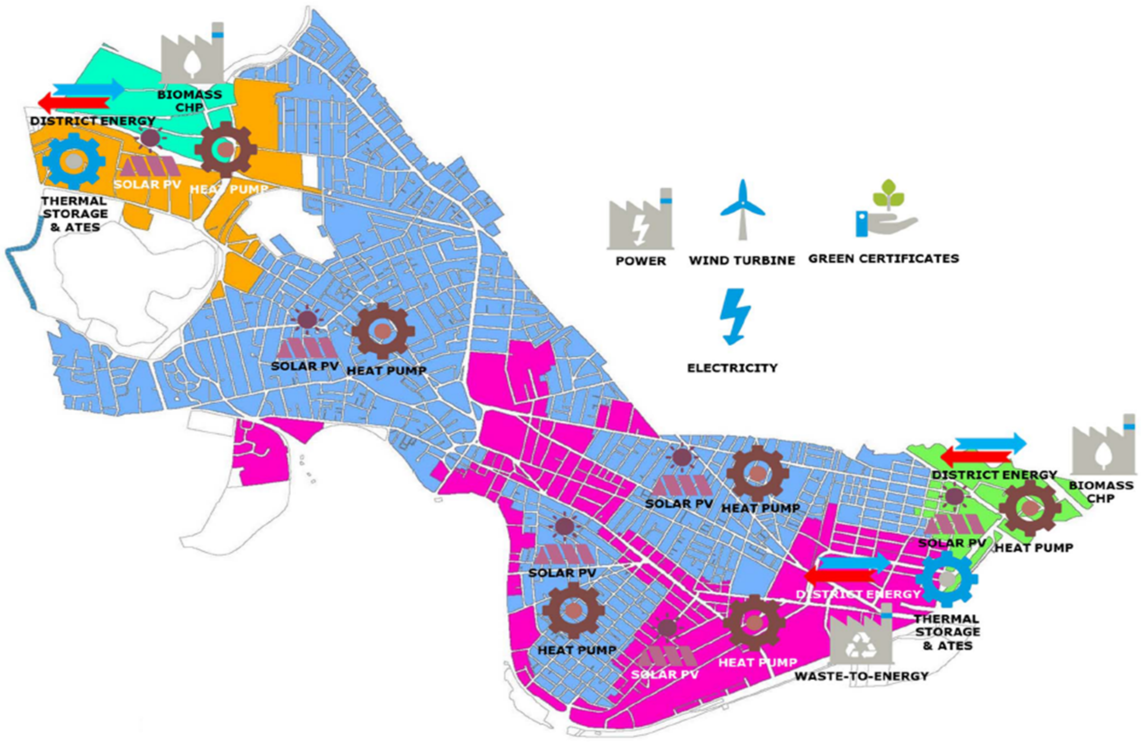
- **Financial risks**
- **Legal/Policy risks**
- **Technical Risk**
  - Civil Works
  - Plant
  - Sewer heat
  - Charles River use
- **Energy Supply risks**
- **Environmental risks**

Stakeholder concensus risks

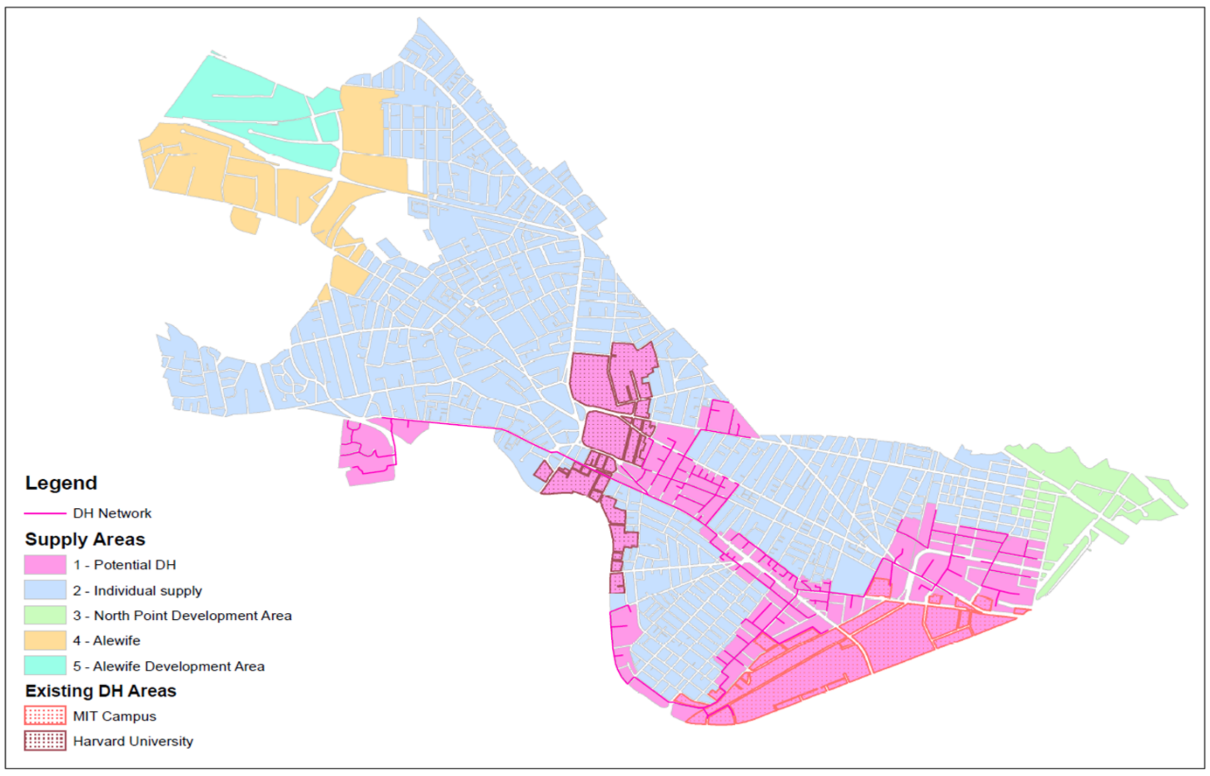
- Utility / network owners
- Plant owners
- Universities
- Climate Protection Action committe
- Compact for a Sustainable Future
- Boston
- Sommerville
- City internal

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Lack of Biomass supply	Sustainable supply chain not existent	Plant operator	Commercial	Significant market demand needs to be established to grow biomass supply chain
2	Lack of Biomass supply	Sustainable supply chain not existent	City	Environmental	Develop recognised sustainable standard for biomass for suppliers to comply with and develop crop for
3	Lack of regulation	Hot Water DH not currently regulated in MA	City	Legal/Policy	Regulation and policy to be developed to address HW
4	Lack of regulation	Hot Water DH not currently regulated in MA	City	Commercial	Tariff policy for HW supply to be developed
5	Lack of regulation	Hot Water DH not currently regulated in MA	City	Technical	Design standards to be developed
6	Residential Heat Pumps	Grid reinforcement in blue areas?	Eversource	Energy supply/Resilience	City to plan incentisation of HPs etc. with Eversource to ensure upgrades are implemented as required
7	establishment of DHC network	physical impact - available space in road?	Owner of Network?	Commercial	improved mapping of utilities
8	establishment of DHC network	physical impact - available space in road?	Owner of Network?	Legal/Policy	improved mapping of utilities
9	establishment of DHC network	physical impact - available space in road?	Owner of Network?	Stakeholder	improved mapping of utilities
10	Existing utility locations	Ability to provide utility mapping to developers	Owner of Network?	Legal/Policy	Address issue with legislator
11	Transferring consumers to DHC	Getting buildings to connect to the network	Owner of Network?	Commercial	Make mandatory to connect? Incentivise by lower price
12	Space in road for infrastructure	4 pipes for DHC - lack of space	Owner of Network?	Financial	Deep installation is costly
13	Lack of connections	low number of property owners for cooling - risk of no ageement or all agree to connect	Owner of Network?	Commercial	Stakeholder engagement on benefits
14	Siting generation	siting the plants	Owner of plants	Financial	Appropriate zoning by City
15	Siting generation	siting the plants	Owner of plants	Legal/Policy	Address issue with legislator
16	Siting generation	siting the plants	Owner of plants	Technical	Appropriate zoning by City
17	Siting generation	siting the plants	Owner of plants	Environmental	Appropriate zoning by City
18	DH network existing owner connections	University and Veolia cooperation	City	Stakeholder	Stakeholder engagement on benefits
19					
20					

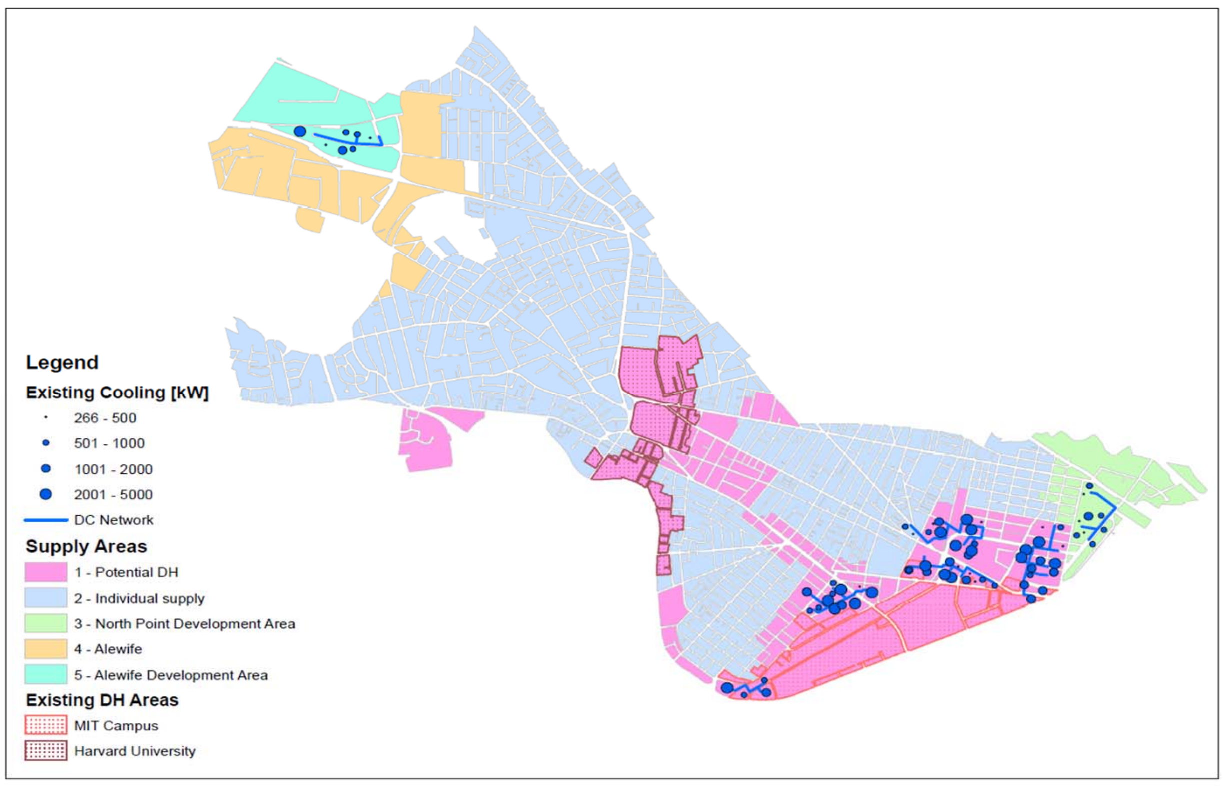
2040 - Scenario 4 Established - DHC with City Generation



HEATING NETWORK POTENTIAL ZONE 1



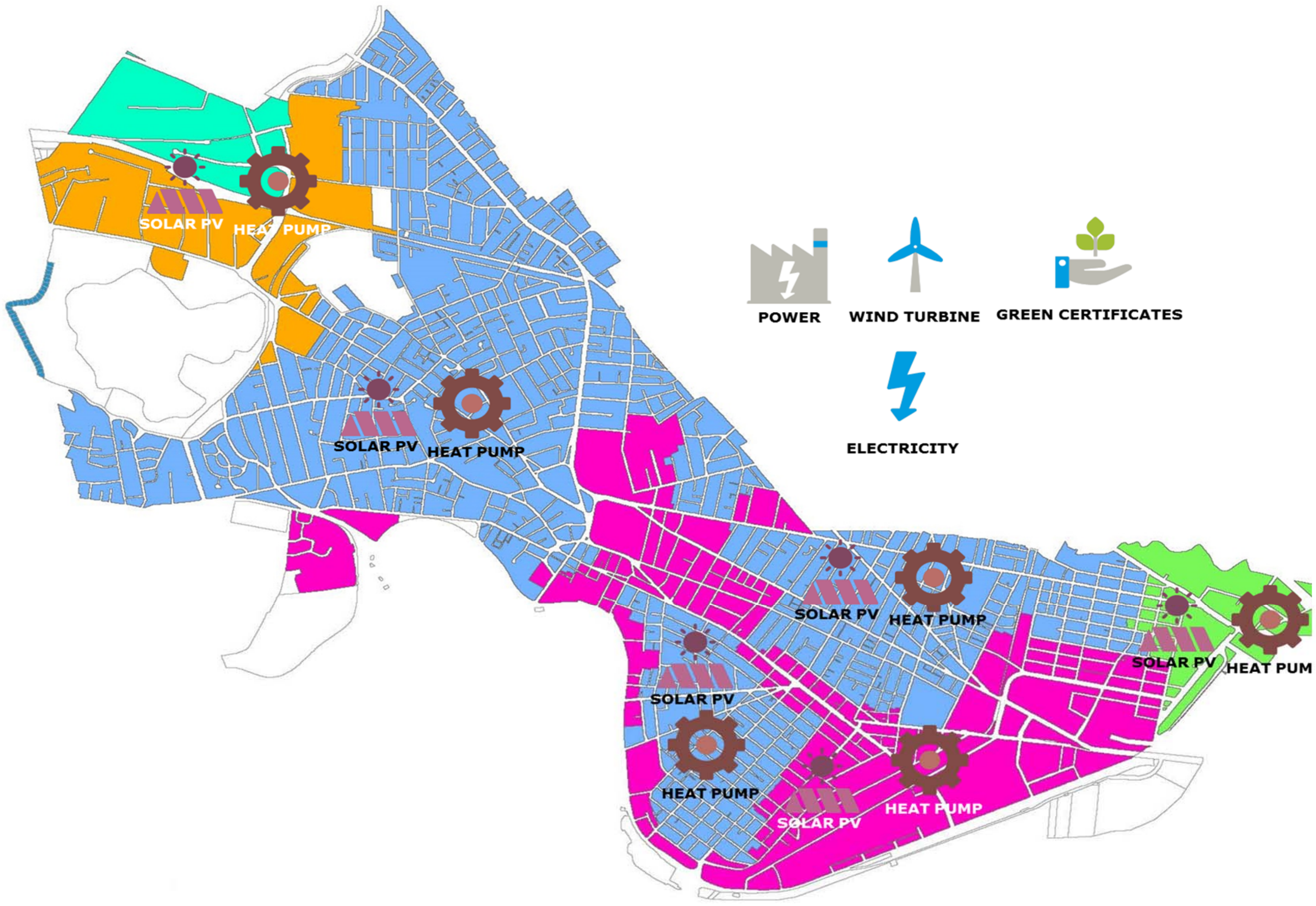
COOLING NETWORK POTENTIAL ALL CITY



LCESS Risk Scenario Risks	**Risk Categories to Consider**		
06.27.2017	**Financial risks**	**Stakeholder concensus risks**	
Scenario 1	**Legal/Policy risks**		Utility / network owners
	Technical Risk		Plant owners
What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.	Civil Works		Universities
	Plant		Climate Protection Action committe
			Compact for a Sustainable Future
			Boston
	Energy Supply risks		Sommerville
	Environmental risks		City internal
			Plant

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Electrical Company cooperation	Grid modernisation out of control - Eversource may not be prepared to upgrade for this path forward	Eversource	Commercial	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
2	Electrical Company cooperation	Grid modernisation out of control - Eversource may not be prepared to upgrade for this path forward	City	Environmental	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
3	Power failure	Not resilient infrastructure as above ground	Eversource	Energy supply/Resilience	look at putting infrastructure below ground
4	Power failure	Not resilient infrastructure as above ground	City, commerical sector	Financial	Improve resilience
5	Control over low carbon supply	Limited control on how green imported electricity is	City	Environmental	Power Purchase agreements for RES
6	Consumer compliance with implementation	Building may not convert to electric	City	Environmental	Educate public of need for change, incentivise change
7	Consumer compliance with implementation	Building may not convert to electric	Eversource	Commercial	Consumer communication over benefits, incentivisation
8	Stranded assetts	Gas infrastructure not at end of design life / commerical payback, Electrical infrastrucutre not utilised	Eversource	Commercial	City wide assetts management planning in combination with integration of new energy sources
9	Cost Risk	Cost risk - competitive with gas?	Residents	Financial	City ensure best socio-economic path chosen for low carbon supply
10	Electrical Company cooperation	Eversource not being happy with decentralised on-site generation	Eversource	Technical	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
11	Electrical Company cooperation	Eversource not being happy with decentralised on-site generation	Residents	Commercial	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
12	Electrical Company cooperation	Investment in Cambridge only may be difficult for Company to justify	Eversource	Technical	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
13	Electrical Company cooperation	Investment in Cambridge only may be difficult for Company to justify	Eversource	Financial	Full Utility buy in required to Scenario. Discussions with company, develop methods of incentivisation within City's powers.
14					

2040 - Scenario 1 Established - Electrification

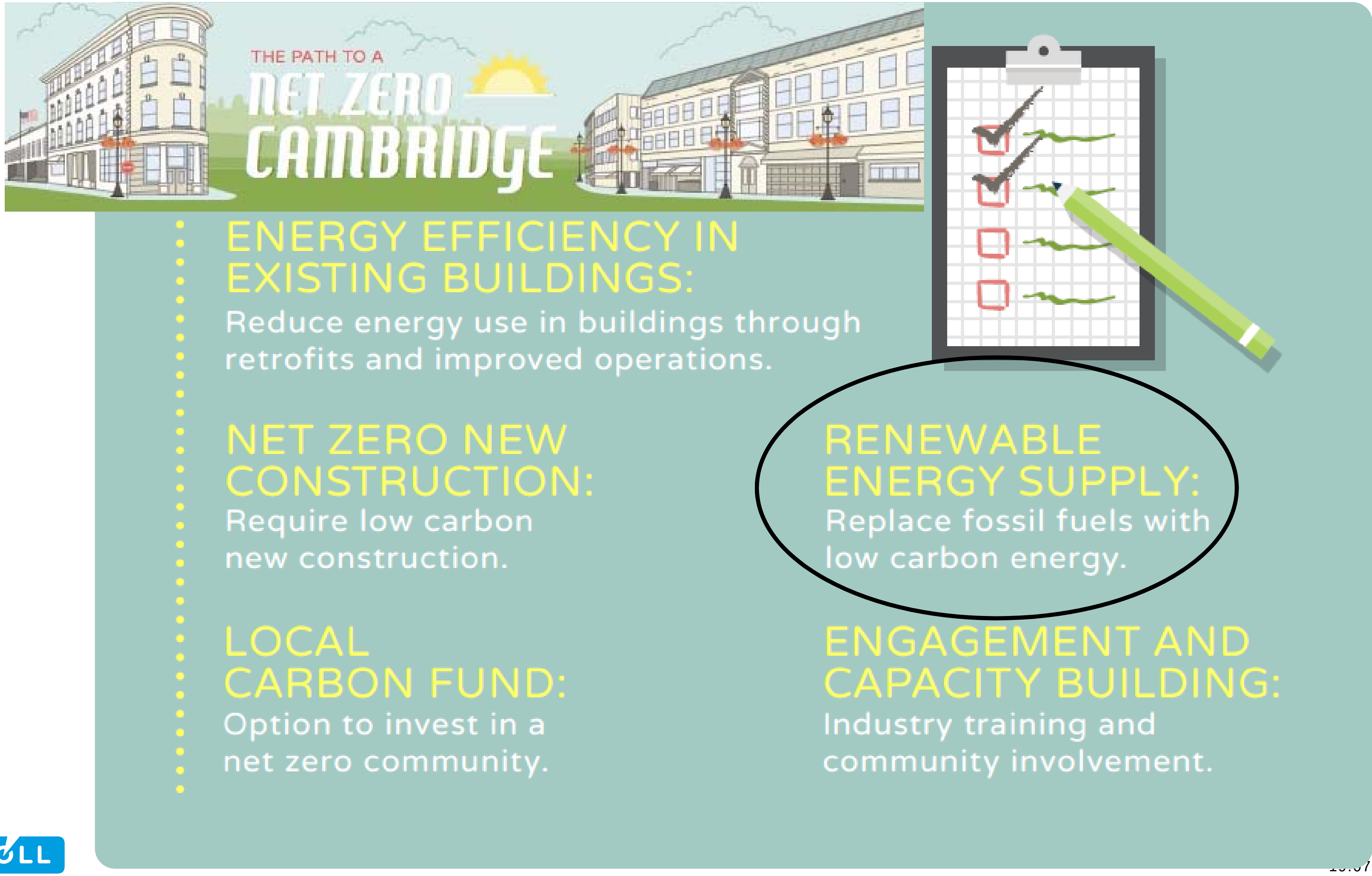


APPENDIX 4
WORKSHOP 4 POWERPOINT PRESENTATION

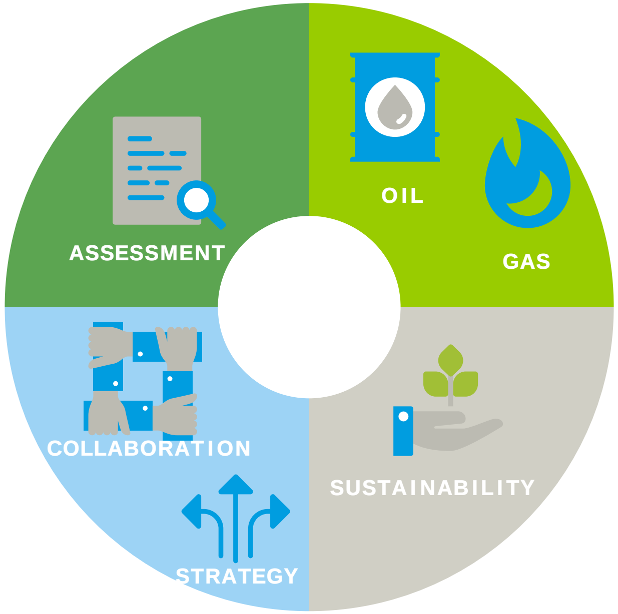
LOW CARBON ENERGY SUPPLY STRATEGY STUDY, CAMBRIDGE, MA

ADVISORY COMMITTEE MEETING WORKSHOP 4

PROJECT BACKGROUND

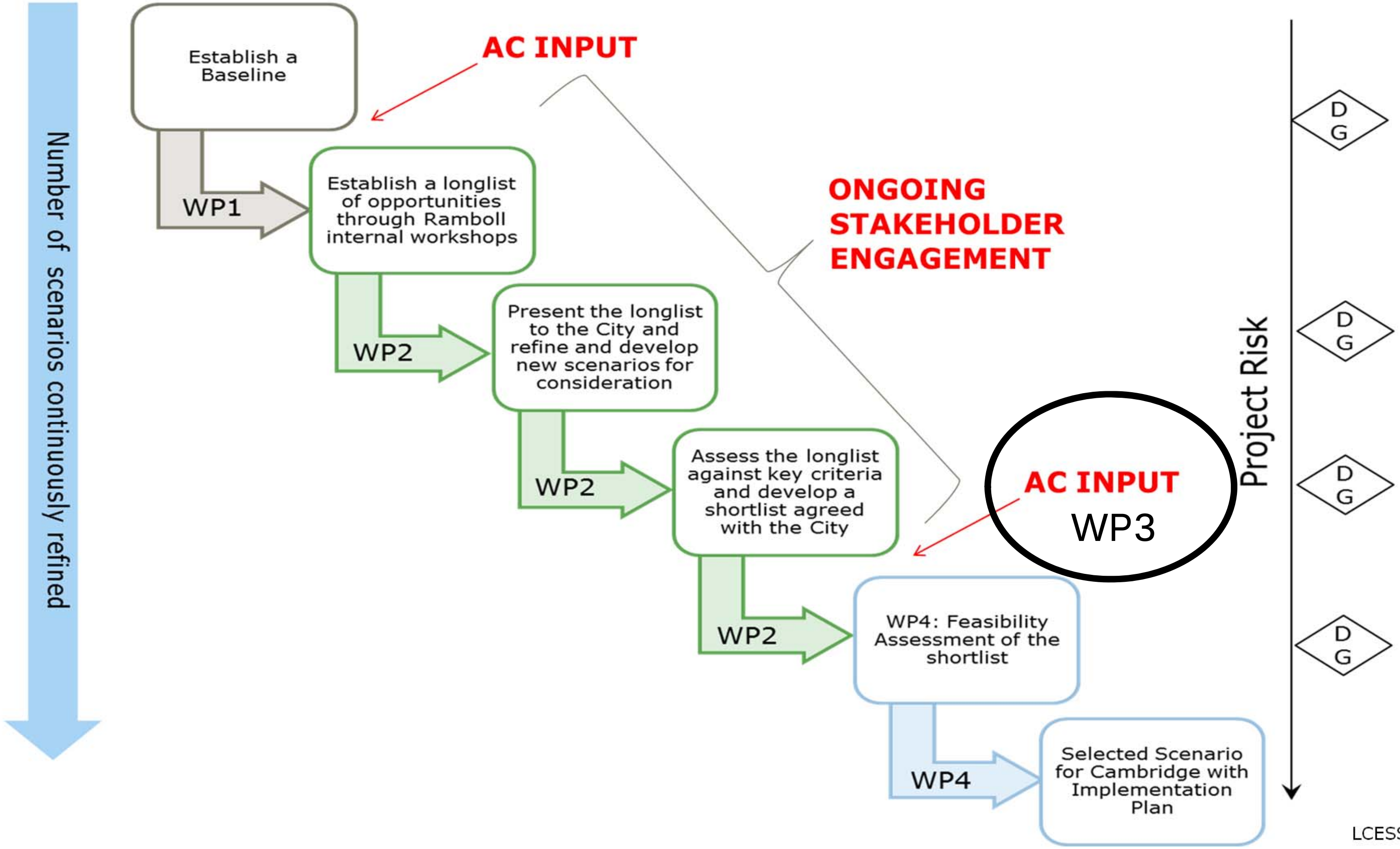


PROJECT COMPONENTS AND CURRENT STATUS



- Work package 1: Baseline situation assessment of City's current energy supply and barriers to low carbon
- Work Package 2: Low Carbon Scenarios Development
- **Work Pacakge 3: Change and Benefit Management**
- Work Package 4: Technical and economic viability assessment

SCENARIO DEVELOPMENT PROCESS – ITERATIVE ENGAGEMENT AND EVOLUTION OF SCENARIOS



AGENDA

MEETING OBJECTIVE: Identify the Benefits and Risks associated with each scenario shortlisted for the LCESS

PURPOSE:

- Further evaluation of Scenarios
- Discuss frameworks through which these scenarios could be achieved
- Identify barriers to be addressed to facilitate change

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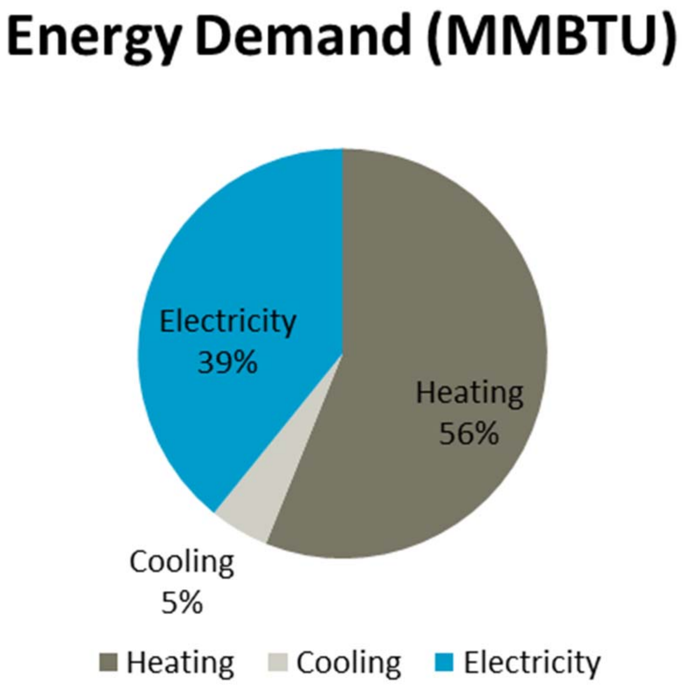
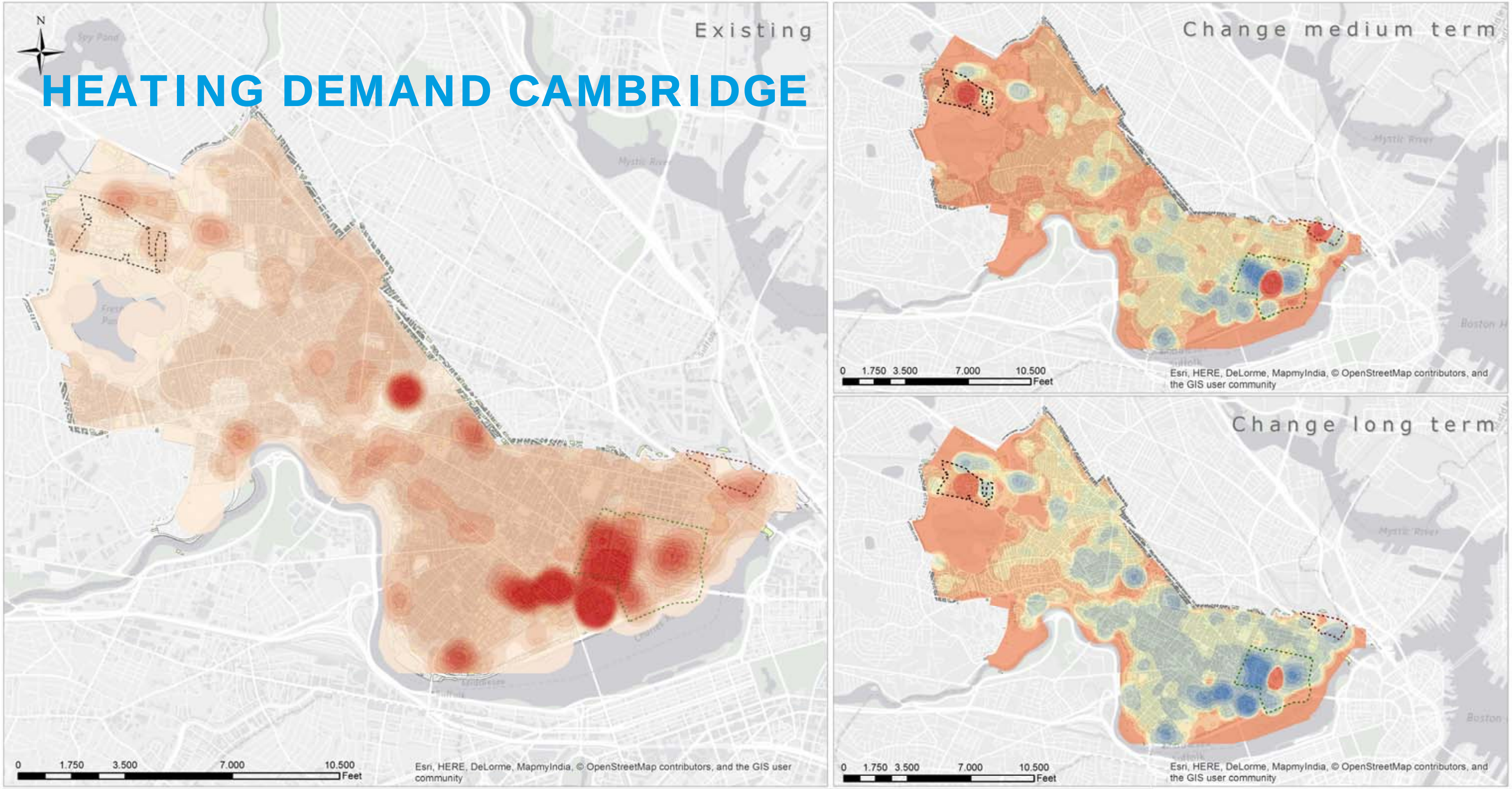
CURRENT ENERGY DEMANDS OF CITY – NOTE THERMAL ENERGY SIGNIFICANCE

Demand Type	Energy Demand (MMBTU)	Energy Demand (MWh/yr)
Heating	6,060,000	1,776,010
Cooling*	508,000	148,880
Electricity	4,230,000	1,239,690
Total	10,798,000	3,164,581



HEATING DEMAND CAMBRIDGE



Landuse parcels
Buildings
AleWife
Kendall_Square
Northpoint

Thermal Demand by kBTU/sq.ft	Change by kBTU/sq.ft
2 - 10	-130.8 - -75.0
11 - 20	-74.9 - -50.0
21 - 40	-49.9 - -25.0
41 - 60	-24.9 - -10.0
61 - 80	-9.9 - -7.5
81 - 100	-7.4 - -5.0
101 - 125	-4.9 - -2.5
126 - 150	-2,4 - 2.5
151 - 200	2.6 - 100.0
201 - 621	100.1 - 451.8

Rev.	Date	Signature	Checked	Approved
1	03/02/2017	SDJ	MK	IMC

Project no. 1100025630

CITY OF CAMBRIDGE ENERGY MASTERPLANNING

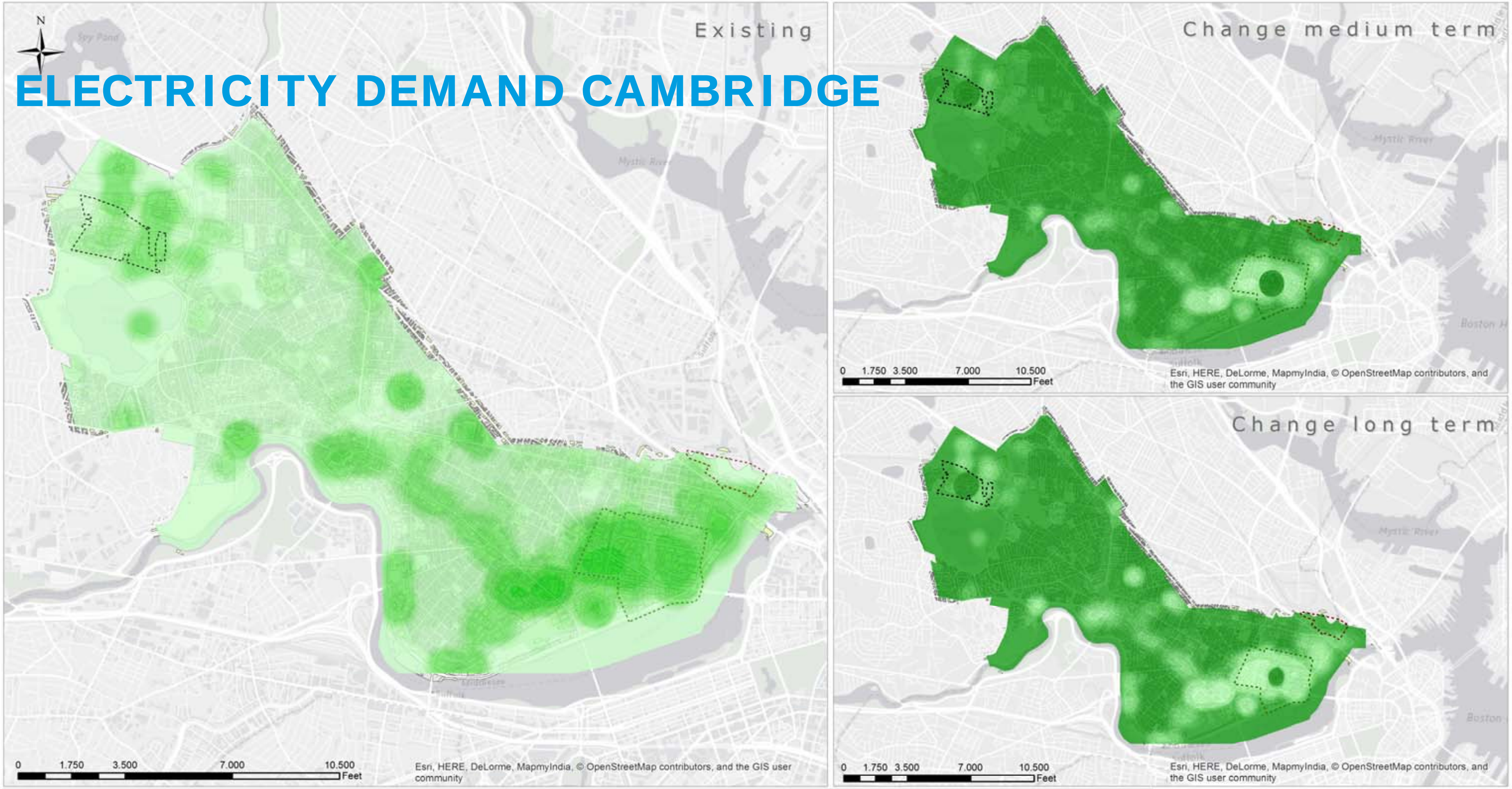
Heat demand (current, medium and long term)

RAMBOLL

Hannemanss Allé 53
2300 Copenhagen S
Denmark
www.ramboll.com

cambridgema.gov

ELECTRICITY DEMAND CAMBRIDGE



Landuse parcels
Buildings
AleWife
Kendall_Square
Northpoint

Electricity Demand by kBTU/sq.ft	Change by kBTU/sq.ft
0 - 5	-77 - -50
6 - 10	-49 - -20
11 - 15	-19 - -15
16 - 20	-14 - -10
21 - 25	-9 - -8
26 - 50	-7 - -5
51 - 75	-4 - -3
76 - 100	-2 - 0
101 - 250	1 - 100
251 - 453	101 - 315

Rev.	Date	Signature	Checked	Approved
1	03/02/2017	SDJ	MK	IMC

RAMBOLL

Hannemanss Allé 53
2300 Copenhagen S
Denmark
www.ramboll.com

Project no. 1100025630

CITY OF CAMBRIDGE ENERGY MASTERPLANNING

Electricity demand (current, medium and long term)

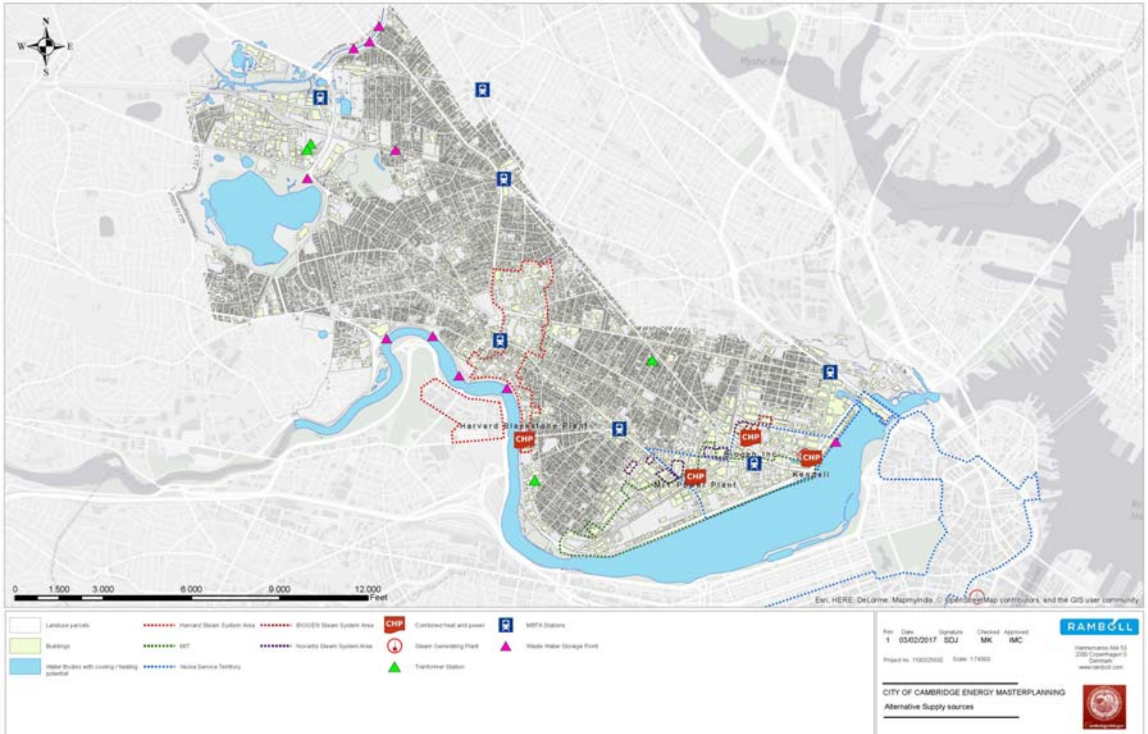
cambridgema.gov

COOLING DEMAND CAMBRIDGE

LCESS AC WORKSHOP 4
19.07.2017

CAMBRIDGE ENERGY CHALLENGE: LIMITED OPTIONS FOR RENEWABLE SOURCES IN A BUILT OUT ENVIRONMENT SUCH AS CAMBRIDGE

- Limited space for siting of
  - Solar panels
  - Wind turbines
  - Generation plants
  - Biomass delivery
- Limited waste heat sources
- Limited waste heat sinks
- Poor deep geothermal potential
- Space limitations for exploiting shallow geothermal for Ground Source Heat Pumps



RAMBOLL

AGENDA

MEETING OBJECTIVE: Identify the Benefits and Risks associated with each scenario shortlisted for the LCESS

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- Further evaluation of Scenarios
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CASE STUDY: CITY OF MELBOURNE PATHWAY TO CARBON NEUTRALITY BY 2020, POPULATION 0.1M

2001
Mandatory Renewable Energy Target (MRET) was introduced committing Australia to 20% RES by 2020

2001
First Victorian Wind Farm completed

2002
City of Melbourne established the Sustainable Melbourne Fund

2003
Queen Victoria Market Solar array installed (252MW capacity) saving >350 tons CO2 inn 2003-2004

2003
1st Net Zero Emissions strategy

2005
First car share initiative launched in Melbourne

2006
Australia's first 6 star Green Star designed office building was built. Saving 500 tons CO2 per year compared with a typical office building

CASE STUDY: CITY OF MELBOURNE PATHWAY TO CARBON NEUTRALITY BY 2020, POPULATION 0.1M

2007
Australia ratified Kyoto protocol committing to 5% GHG reduction on 1990 levels

2008
Net Zero Emissions Strategy Update

2010
City of Melbourne launched the 1200 buildings program to improve commercial building energy efficiency

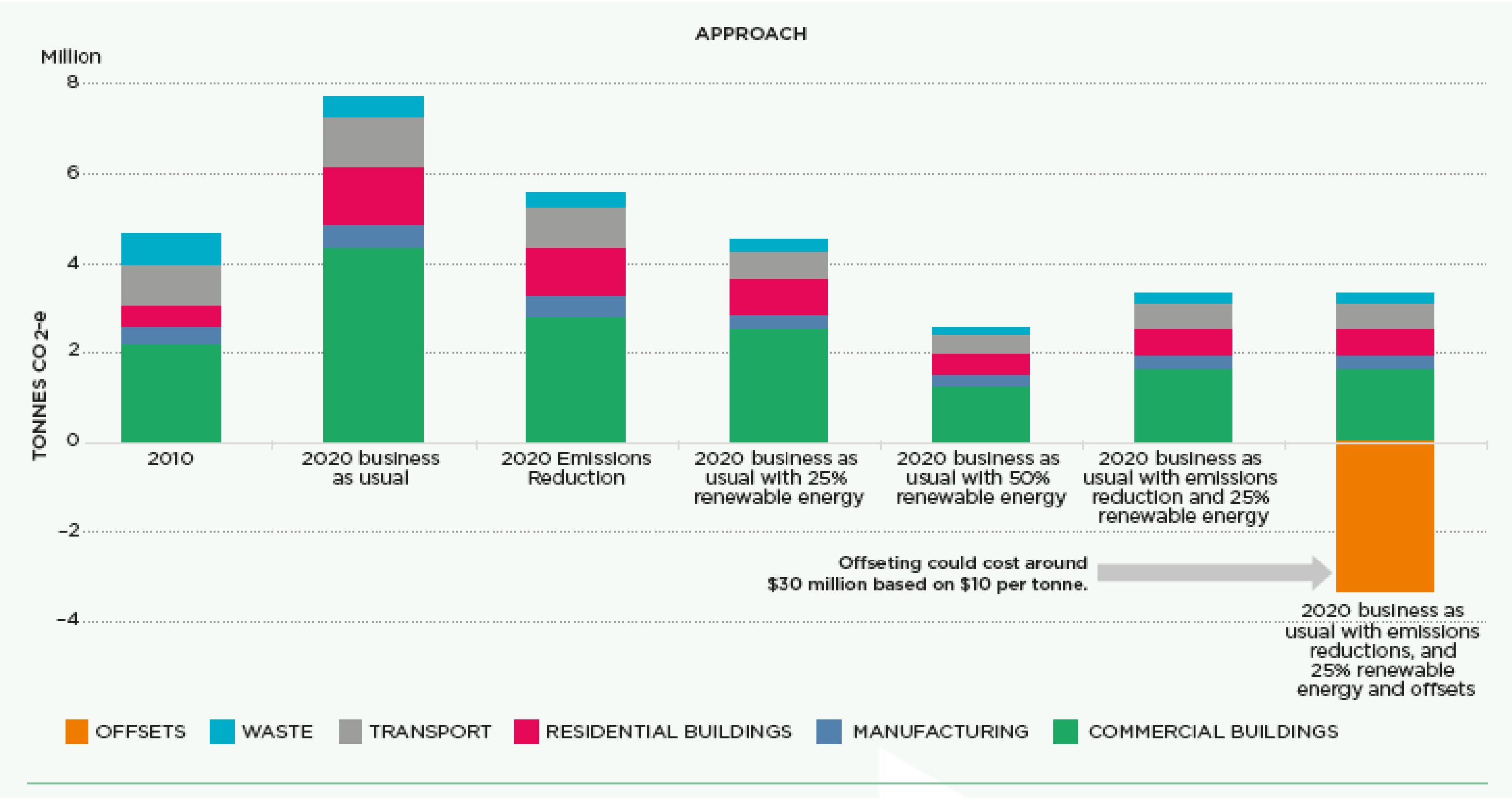
2012
City of Melbourne became NCOS Certified Carbon Neutral for its council operations. 3,028 tons CO2 reduction in 2011-2012 compared with previous year

2003
Completion of Swanson Street Redevelopment increasing public transport and cycling access

2014
Net Zero Emissions Strategy Update

2018
25% of electricity from RES

MELBOURNE'S 2010 EMISSIONS PROFILE AND POSSIBLE FUTURE EMISSIONS SCENARIOS



Focus on:

- Collaborative partnership with primary electricity provider
- RES program promotion
- Solar incentivisation
- District energy promotion
- Distributed energy promotion

CASE STUDY: CITY OF COPENHAGEN PATHWAY TO CARBON NEUTRALITY BY 2025, POPULATION 0.5M

1970's
Oil crisis

1979
1st Heat Law – Obligatory District Heating Connection

1979
1st Energy Plan - Oil & Electricity Taxes Introduced

Taxes

1980
State subsidy of Energy Efficiency introduced

SUSTAINABLE BUILDING

1990
2nd Heat Law – CHP Conversion

CHP POWER

1992
Environmental Taxes Introduced

AIR QUALITY

1995
Greening of Trade and Industry

CASE STUDY: CITY OF COPENHAGEN PATHWAY TO CARBON NEUTRALITY BY 2025, POPULATION 0.5M

AGREEMENT

1993
The Biomass Agreement

2003
Subsidy Restructuring – CHP Mode Operation no longer obligatory to Qualify

Planning

2008
Danish government agreed on a comprehensive agreement regarding Danish energy policy for the period of 2008-2011

CO_2 Neutrality

2009
City Council unanimously adopted the Climate Plan for Copenhagen, setting down goals for achieving a 20% reduction in CO2 Emissions by 2015 compared to 2005

SUSTAINABILITY

2013
Guidelines for achieving carbon neutrality in Copenhagen by 2025 developed

STRATEGY

2025
- District Heating is Carbon Neutral
- Power generation based on wind and biomass exceeds City needs
- Separation of plastic from waste
- Bio-gasification of organic waste

CITY OF COPENHAGEN CHALLENGES, GOALS AND INITIATIVES TOWARDS 2025 TARGET

Challenges

- Lack of base load facilities
- Deregulation of the waste sector affecting WtE supply
- Need for a flexible energy supply combined
- Collaboration across the municipalities in Greater Copenhagen area needed
- Economic growth and considerable population growth expected in Copenhagen.
- Carbon neutral district heating requires the conversion of peak load supply to carbon neutral fuels and a separation of plastic from the incinerate able waste.
- Electricity needed for heat pumps in e.g. geothermal facilities will continue to emit CO2 until the production of electricity has been converted into renewables

Goals and Initiatives:

- Establishment of guilds for wind turbine shares sold to citizens and businesses in Copenhagen.
- Offshore and land-based wind turbines for 360 MW (100 turbines) have been installed
- Combined heat and power production in Copenhagen is converted to biomass
- A new wood-fired combined heat and power plant has been established
- A geothermal facility of at least 50MW has been established together with an additional one before 2030
- Peak-load production has been converted to carbon neutral fuels
- Gasification of organic waste
- A full-scale REnescience or biogas facility has been established
- Plastic from households and businesses are separated from the waste stream

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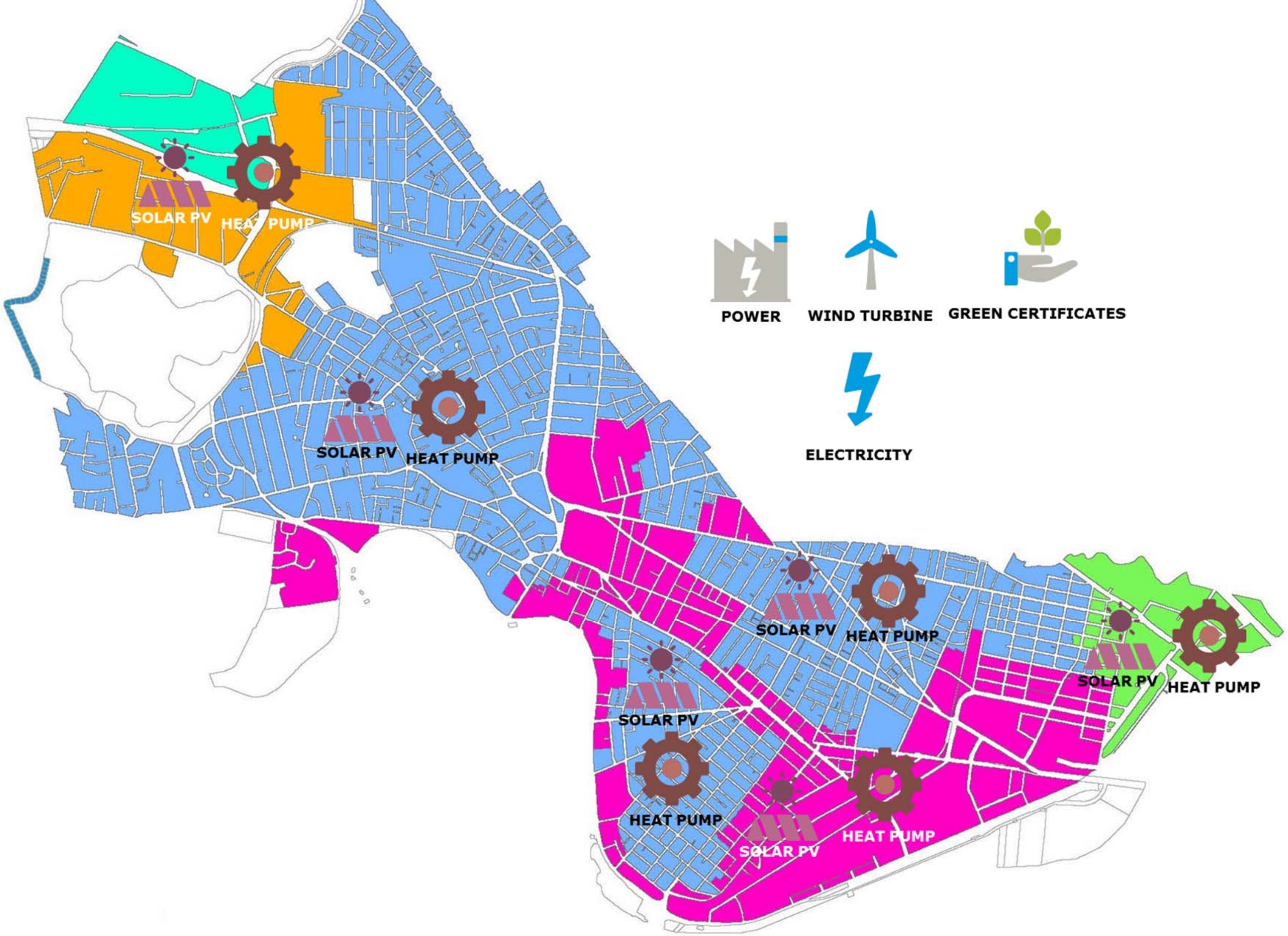
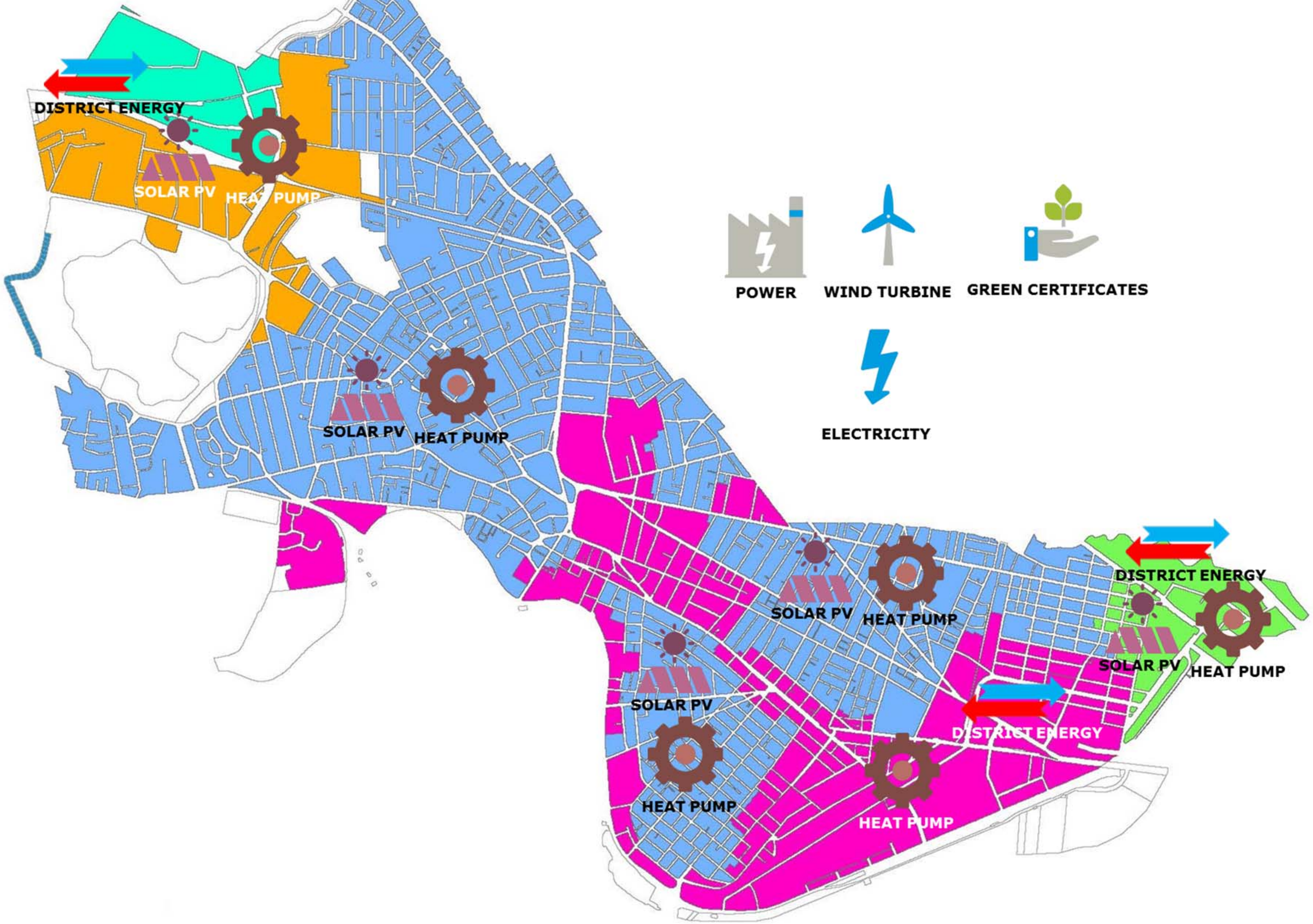
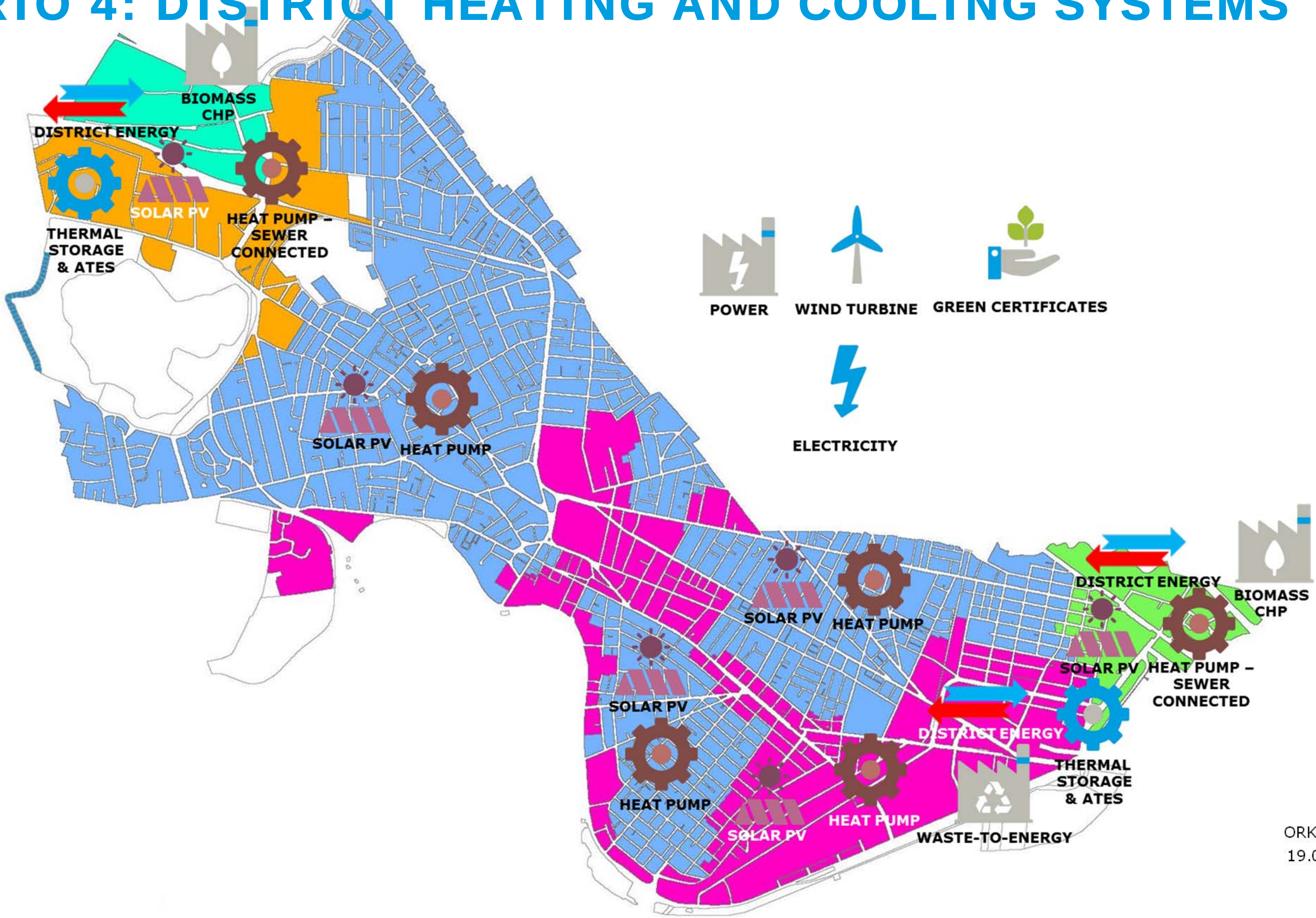
SCENARIO 1: INDIVIDUAL ELECTRIFICATION



SCENARIO 2: DISTRICT ENERGY ELECTRIFICATION



SCENARIO 4: DISTRICT HEATING AND COOLING SYSTEMS



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WORKSHOP PROCESS

- Benefit Mapping Workshop (20 mins)
- Benefits identified discussion from each team (20 mins)

Scenario 1 Team	Scenario 2 Team	Scenario 4 Team A (biomass)	Scenario 4 Team B (WTE)
James Cater	Seth Federspiel	Susanne Rasmussen	Ellen Katz
Melissa Chan	Samantha Meserve	Adam Jacobs	Oliver Sellers-Garcia
Josh Kessler	Tina Miller	Mary Smith	Melissa Peters
John Bolduc	John Cleveland	Patrick Haswell	Steve Lanou

CITY ENERGY SUPPLY GOALS: CONSIDER THE BENEFITS OF EACH SCENARIO IN RELATION TO THE CITY'S GOALS

- Clean: Reduce carbon emissions and toxic pollutants created by the system.
- Reliable: Minimize system downtime from outages and ensure high quality of power delivered.
- Affordable: Keep rates as low as possible and maintain competitiveness.
- Predictable: Minimize rate volatility.
- Transparent: Consumers can understand their power costs and what drives changes in costs.
- Local Control: Give residents greater control over their energy resources and energy choices.
- Wealth Creating: Keep more energy revenue in the local economy instead of exporting it to outside suppliers — to help drive local economic development, create new businesses and jobs.
- Innovative: The system spawns innovation, intellectual property creation, and entrepreneurship.
- Just: The system promotes "energy equity," protecting vulnerable populations from undue hardship, and promotes energy literacy.

AGENDA

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WORKSHOP PROCESS

- Risk identification Workshop (20 mins)
- Risks identified discussion from each team (20 mins)

Scenario 1 Team	Scenario 2 Team	Scenario 4 Team A (biomass)	Scenario 4 Team B (WTE)
James Cater	Seth Federspiel	Susanne Rasmussen	Ellen Katz
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TEMPLATE FOR RISKS

Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
		Plant operator	Technical	
		Plant Owner	Legal/Policy	
		Electrical Grid owners/operator	Financial	
		District Heating / Cooling Grid Owner/operator	Stakeholder	
		Gas Network Owner/operator	Energy supply/Resilience	
		Academic Institution	Environmental	
		City	Commercial	
		Commercial Sector		
		Residents		
		Neighboring City		

AGENDA

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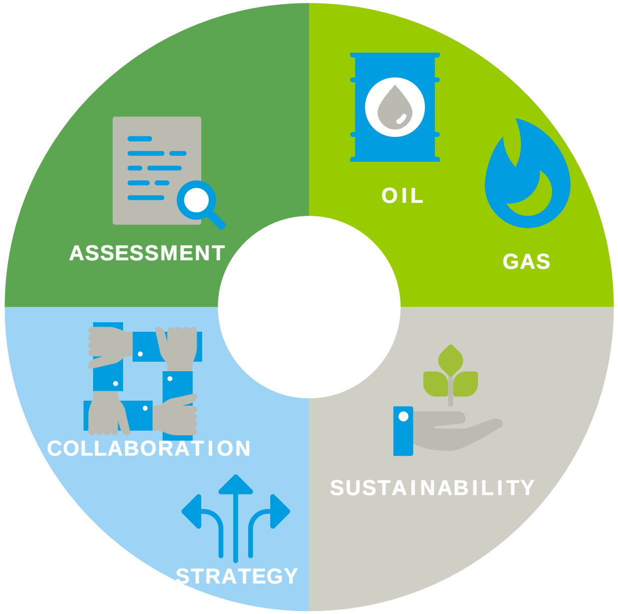
PROJECT COMPONENTS AND NEXT STEPS



- Work package 1: Baseline situation assessment of City's current energy supply and barriers to low carbon
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- Work Package 4: Technical and economic viability assessment

THANK YOU

APPENDIX 5
BENEFITS IDENTIIED BY ADVISORY COMMITTEE

BENEFIT MAP FOR SCENARIO 1 ELECTRIFICATION

Scenario Technologies	Scenario benefits Identified by Team	
Electrical Grid (HV and LV), substations etc. upgrade	Air quality improvement – removal of gas and oil boilers – regional impacts however?	Opportunity for technical advancement over time
Individual Electric Boilers	Need for greater electrical supply – opportunity to improve grid resilience	Hyper local control – landlord can manage the system (or offload)
Individual Heat Pumps	PACE for commercial and residential can help with financing	Facilitates adaptation to rising temperatures / climate change
Individual Chillers	Additional central air conversion possible	Potentially more space in buildings as no boilers– enhances property space / value
Solar PV / Solar Thermal	Can customize by function and location ie. per building rather than centralised approach	Local installation needed – green collar jobs
External to City electrical generation and supply	Easier to meter and measure individual users	Opportunity to participate in demand response
	Larger market pushes innovation	

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TEAM
John Bolduc
Melissa Chan
Adam Hasz

BENEFIT MAP FOR SCENARIO 2
DISTRICT ENERGY ELECTRIFICATION

Scenario Technologies	Scenario benefits	
Individual Chillers	District energy users won't see much change in service as fuel sources change	Local air quality benefits – however likely to be a regional impact on air quality
Individual Electric Boilers and Heat pumps	Large clean energy procurement can reduce CO_2 of grid electricity	Central heat pumps are flexible
District heating and cooling, heat pumps and thermal storage	Opportunity for energy storage; ATES, Battery if affordable	
District heating and cooling, chillers and thermal storage	Potential for less individual costs if shared infrastructure is paid for by City / third party	
District heating and cooling, electric boilers and thermal storage	No combustion emissions within City	
External to City electrical generation and supply	Multiple media (air, ground, water) options for central heat pumps	
Solar PV / Solar Thermal	Storage can help address volatility of grid prices (mitigate peaks) – demand management?	

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TEAM
Seth Federspiel
Samantha Meserve
John Cleveland

BENEFIT MAP FOR SCENARIO 4 WTE DISTRICT HEATING AND COOLING

Scenario Technologies

- Biomass CHP, Biomass heat generation, Waste to Energy
- Individual Electric Boilers, Heat pumps and Chillers
- District heating and cooling, heat pumps and thermal storage–sewers & other sources
- District heating and cooling, chillers and thermal storage
- District heating and cooling, electric boilers and thermal storage
- External to City electrical generation and supply
- Solar PV / Solar Thermal

Scenario benefits

- Local accountability for City's waste
- Innovative – bringing flexible innovative technologies to bear – eg. Steam to hot water loops
- Improved / optimized waste management practices – "no waste of waste"
- DHC allows for thermal storage
- Opportunity for local control of facility
- Reliable
- Lower temperature heat sources

- Innovative
- Wealth creating
- Local control
- Transparent
- Incentivises being as clean as possible
- Incentivizes optimization of waste stream

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TEAM
Susanne Rasmussen
Adam Jacobs
Mary Smith
Patrick Haswell

BENEFIT MAP FOR SCENARIO 4 BIOMASS DISTRICT HEATING AND COOLING

Scenario Technologies	Scenario benefits	
Biomass CHP, Biomass heat generation, Waste to Energy	Reliable scenario - resilient	Wealth creating
Individual Electric Boilers, Heat pumps and Chillers	Good transition – known technology – can use parts of existing infrastructure	Local line loss reduction
District heating and cooling, heat pumps and thermal storage–sewers & other sources	Local control	Affordable
District heating and cooling, chillers and thermal storage	Transparent – Good baseload diversity	Predictable
District heating and cooling, electric boilers and thermal storage	Diverse source of supply	Clean-ish
External to City electrical generation and supply		
Solar PV / Solar Thermal		

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TEAM
Ellen Katz
Melissa Peters
Steve Lanou

APPENDIX 6
RISKS IDENTIIED BY ADVISORY COMMITTEE

LCESS Risk Scenario Risks
07.19.2017
Scenario 1

What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.	TEAM Melissa Chan John Bolduc Adam Hasz

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Massive adoption	How to educate and incentivise thougands of building owners? Also, there is a limit to the number of installers	Residents, businesses, buildi	Financial	
2	stranded assets / plant investments (near term upgrades)		Plant owners	Financial	
3	Degasification	How do you stop gas service?	Gas utility, City	Legal/Policy	
4	Degasification	What about exisitng gas infrastructure?	Gas utility, City	Financial	
5	Split incentive issue	If success if dependent on smart appliances, is this accessible to everyone? - challenge for renters/landlords	City, renters, landlords, residents	Financial	
6	Split incentive issue	If success if dependent on smart appliances, is this accessible to everyone? - challenge for renters/landlords	City	Legal/Policy	
7	Noise pollution	Does the aggregate noise of Air Pumps rise to an unacceptable level for the City?	Residents and City	Legal/Policy	
8	Noise pollution	Does the aggregate noise of Air Pumps rise to an unacceptable level for the City?	Residents and City	Technical	
9	Increased electricity prices	Grid upgrades will result in higher electrici ty prices which could be rejected by DPU	Grid operator	Legal/Policy	
10	Increased electricity prices	Grid upgrades will result in higher electrici ty prices which could be rejected by DPU	Grid operator	Financial	
11	Buidling electricity upgrades	Might need additional lines, circuit boards	Building owners	Technical	
12	Buidling electricity upgrades	Might need additional lines, circuit boards	Building owners	Financial	
13	Affordability of change	Is transfer of costs to tenants affordable?	Residents	Financial	
14	Asbestos	Upgrades may uncover asbestos which increases cost of works and disposal of materals	Building owners	Financial	
15	Degasification	Gas currently cheaper than heat pumps	Residents	Financial	
16	Tight timeline	Can electrification be acheived in 25 years? Only 1-2 chances for heating upgrades in this period for the 10,000 buildings to be converted.	Building owners	Financial	
17	Tight timeline	Can electrification be acheived in 25 years? Only 1-2 chances for heating upgrades in this period for the 10,000 buildings to be converted.	City	Legal/Policy	

LCESS Risk Scenario Risks
07.19.2017
Scenario 2

What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.	TEAM Seth Federspiel Samantha Meserve John Cleveland

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Infrastructure upgrades	paying for upgrades		Financial	
2	Infrastructure upgrades	Implementing upgrades		Technical	
3	Infrastructure upgrades	Getting buy in		Stakeholder	
4	Not meeting GHG targets	Uncertainty of fuel source		Legal/Policy	
5	Utility interconnection	Utility opposition		Technical	
6	Opposition to transition away from gas	Utility opposition		Legal/Policy	
7	Grid capacity	Significantly increased load will need to be addressed		Technical	
8	Reliability	Grid black/brown out will impact significantly - no increase in reliability		Energy supply/Resilience	Islanding, storage
9	Operation and maintenance	System doesn't work		Technical	
10	Operation and maintenance	Who is responsible?		Legal/Policy	

LCESS Risk Scenario Risks
07.19.2017
Scenario 4 Biomass

What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.	TEAM Susanne Rasmussen Adam Jacobs Mary Smith Patrick Haswell

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Cost to all	Expense	All	Financial	Tax, subsidy, state/federal assistance
2	Delivery	Supply, resilience, transports, delivery	Plant owner	Energy supply/Resilience	Mystic River, Charles River, Train?
3	Environment	Biomass is net Carbon free - really?	All	Environmental	Supply chain criteria, SCR
4	Environment	Transport spill	All	Environmental	
5	Environment	Air emissions	All	Environmental	
6	Legal	Permitting, ownership, policy, operations, 3P	City, utility, plant owner	Legal/Policy	Communication, buy-in, long term policy certainty
7	Ownership	Permitting, ownership, policy, operations, 3P	City, plant owner	Legal/Policy	Long term policy certainty
8	Technical	Exisitng infrastructure in street, new distribution, disruption	All	Technical	Distribution network ownership, City DPW street works budget increase, residents buy in
9	Legal	Natural gas distribution network becomes stranded asset	Gas distribution company	Legal/Policy	?
10	Financial	Natural gas distribution network becomes stranded asset	Gas distribution company	Financial	?

LCESS Risk Scenario Risks
07.19.2017
Scenario 4a WtE

What are the issues / risks you see with having this infrastructure in place from todays perspective? Identify the risks and what catagory they are under.

TEAM
Ellen Katz
Melissa Peters
Steve Lanou

ID	Risk Identified	Description of Risk	Owner of Risk	Risk Category	Mitigation
1	Limited Munisipal Solid Waste availablity	Should waste be imported to City?	Plant owner	Energy supply/Resilience	
2	Local emissions, nuisance		Residents	Environmental	
3	Cost of implementation		Plant owner, residents, customers, rate payers, DHC company	Financial	
4	Proven technology?	Is WtE technology mature enough for wider use?		Technical	
5	Does City have authority to implement	Legal, regulatory, DOER, Utilitym Federal, (FERC etc.)	City, Academic, Residents, owner operators	Legal/Policy	
6	NIMBY	Location	All	Stakeholder	
7	First adopter risk	Is it compatitble with regional efforts and goals?	All	Technical	
8	First adopter risk	Is it compatitble with regional efforts and goals?	All	Financial	
9	First adopter risk	Is it compatitble with regional efforts and goals?	All	Energy supply/Resilience	
10	All risks related to having a WtE plant in local community				