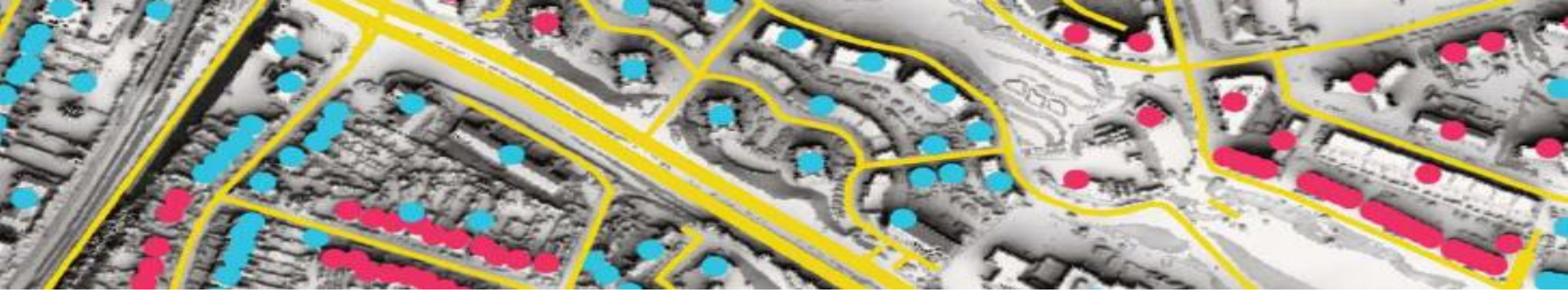


THERMOS

The THERMOS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 723636. The sole responsibility for the content of this presentation lies with its author and in no way reflects the views of the European Union.

THERMOS

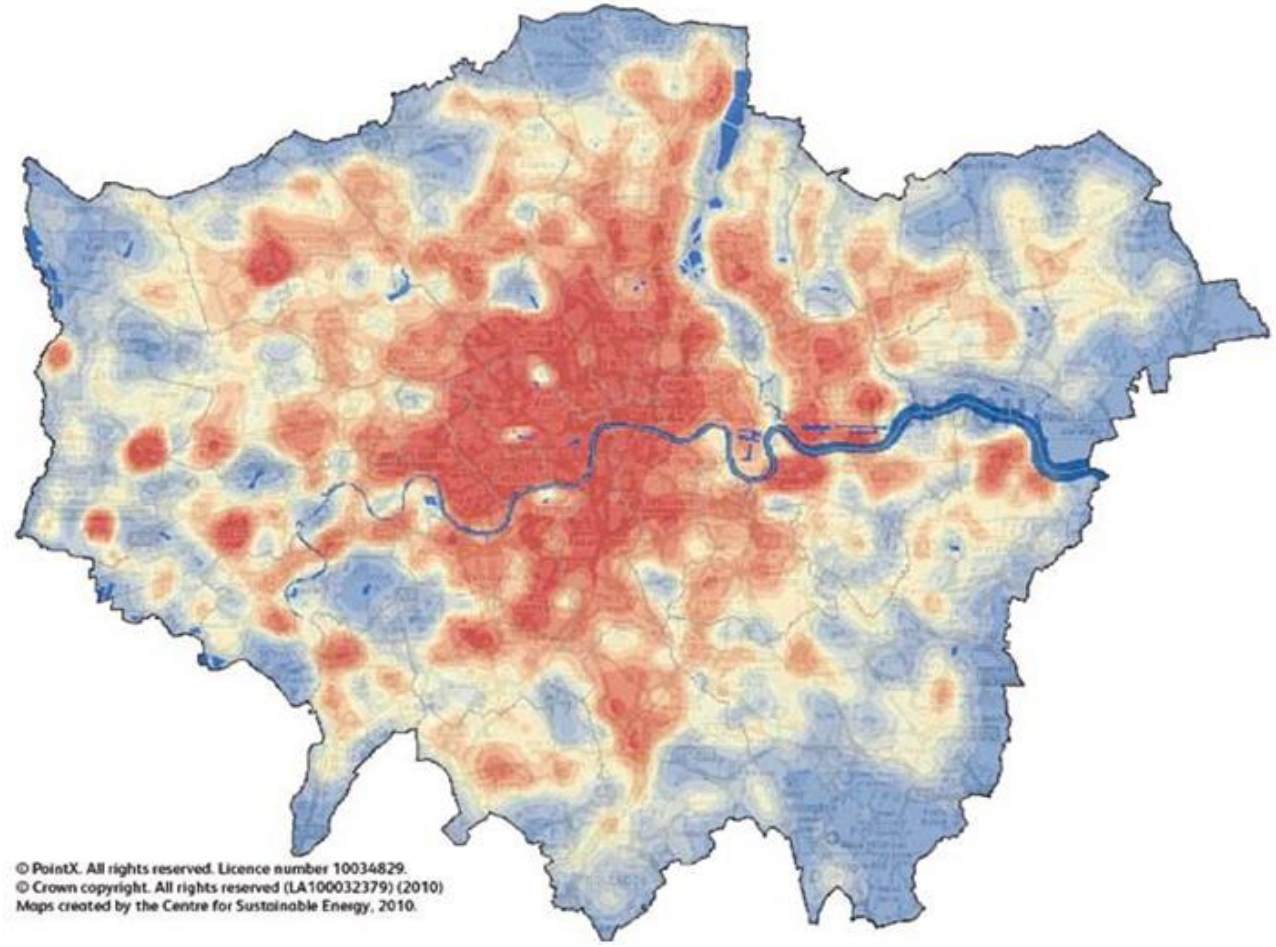
district energy
development ltd

The DHC project lifecycle

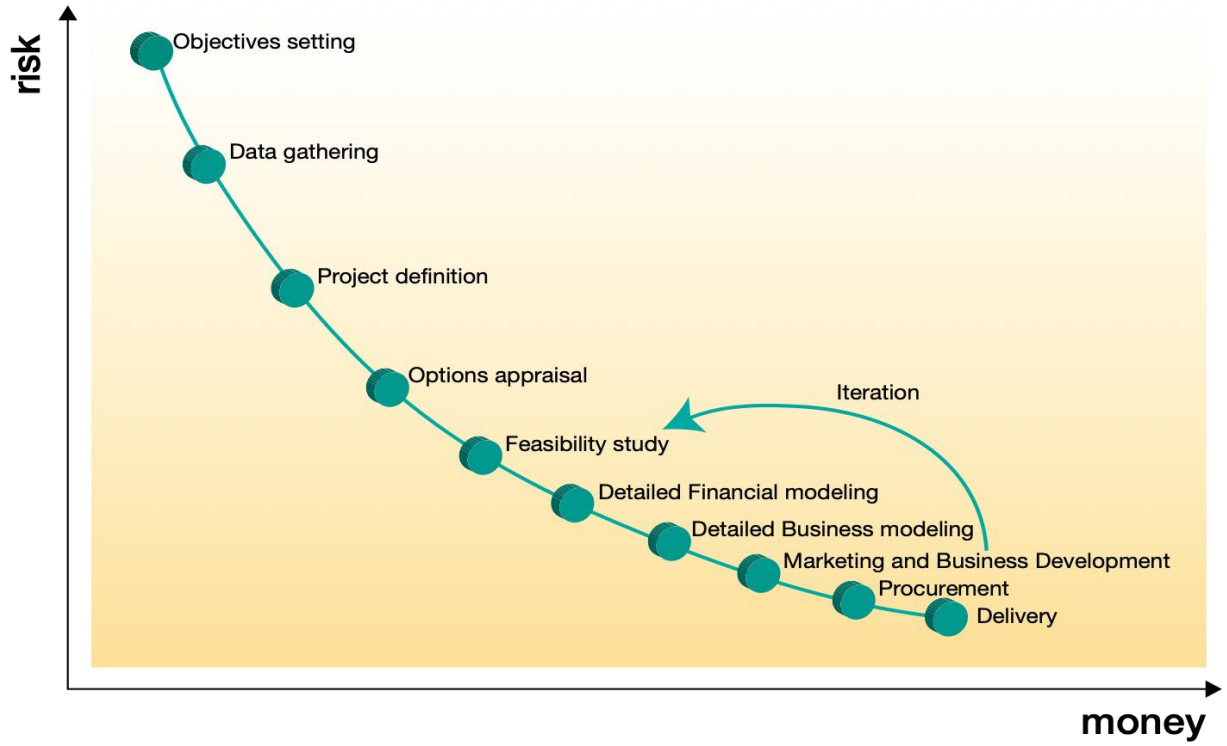
Michael King, district energy development, ltd

IDEA 2019, Pittsburgh, 25 June 2019

London Heat Map

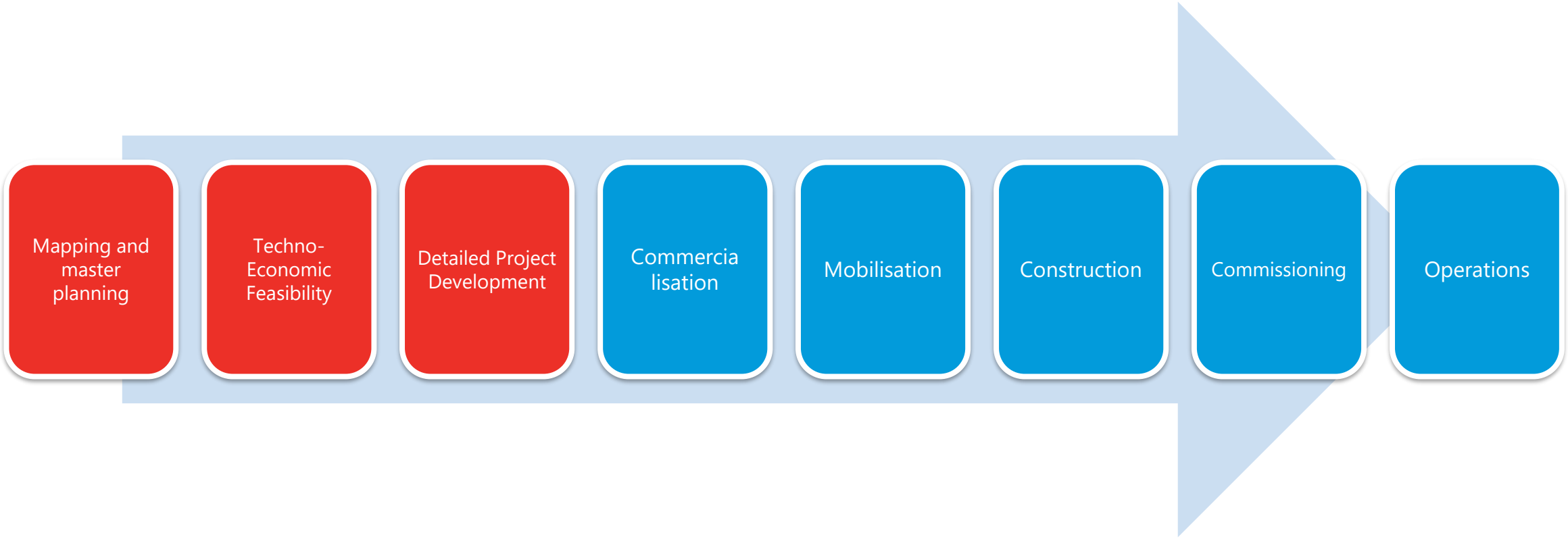


Stages of DHC development



Source: Community Energy. IDEA

THERMOS reduces cost of early stages



Source: BEIS - Heat Networks Delivery Unit Dept Business, Industry & Industrial Strategy UK Government

THERMOS

creara
ENERGY EXPERTS

Introducing THERMOS

Paolo Michele Sonvilla, Creara

IDEA 2019, Pittsburgh, 25 June 2019

The European DHC Market Potential

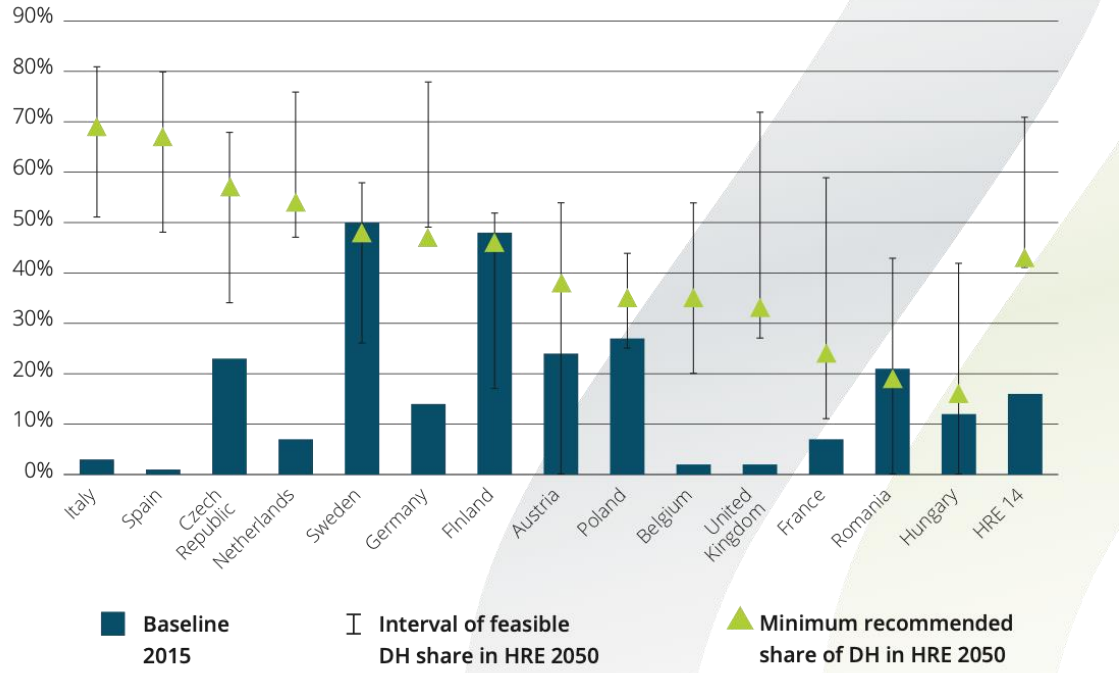
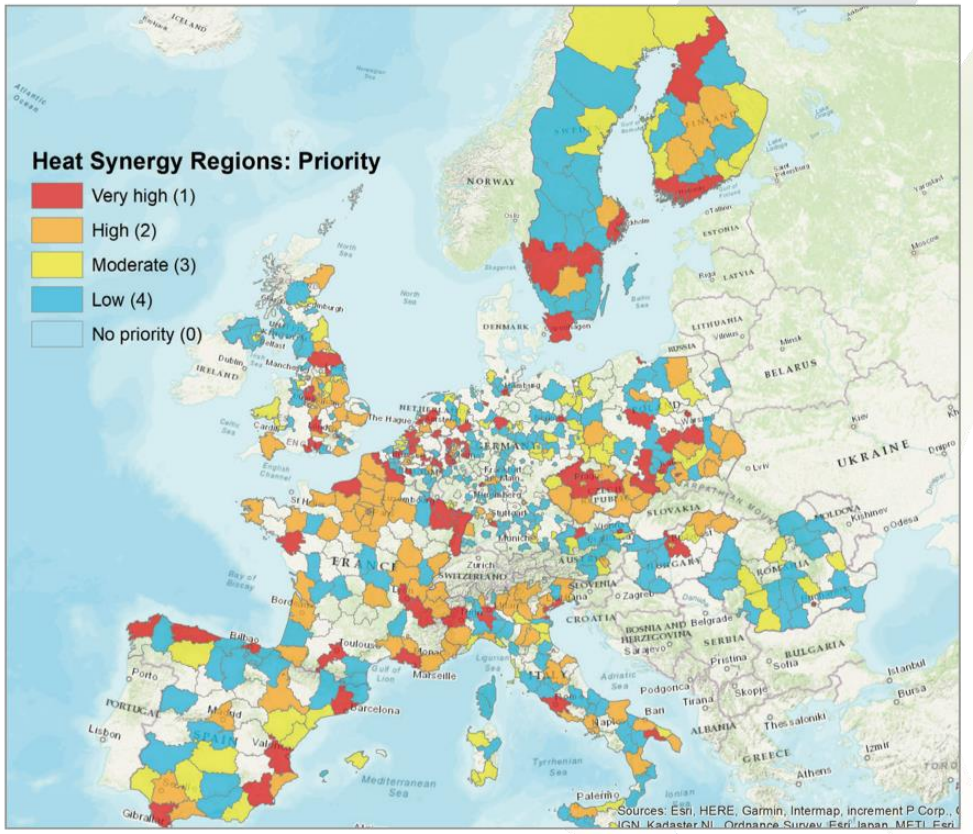


Figure 7. Baseline share of district heating in 2015 and the minimum recommended level of district heating share in HRE4.

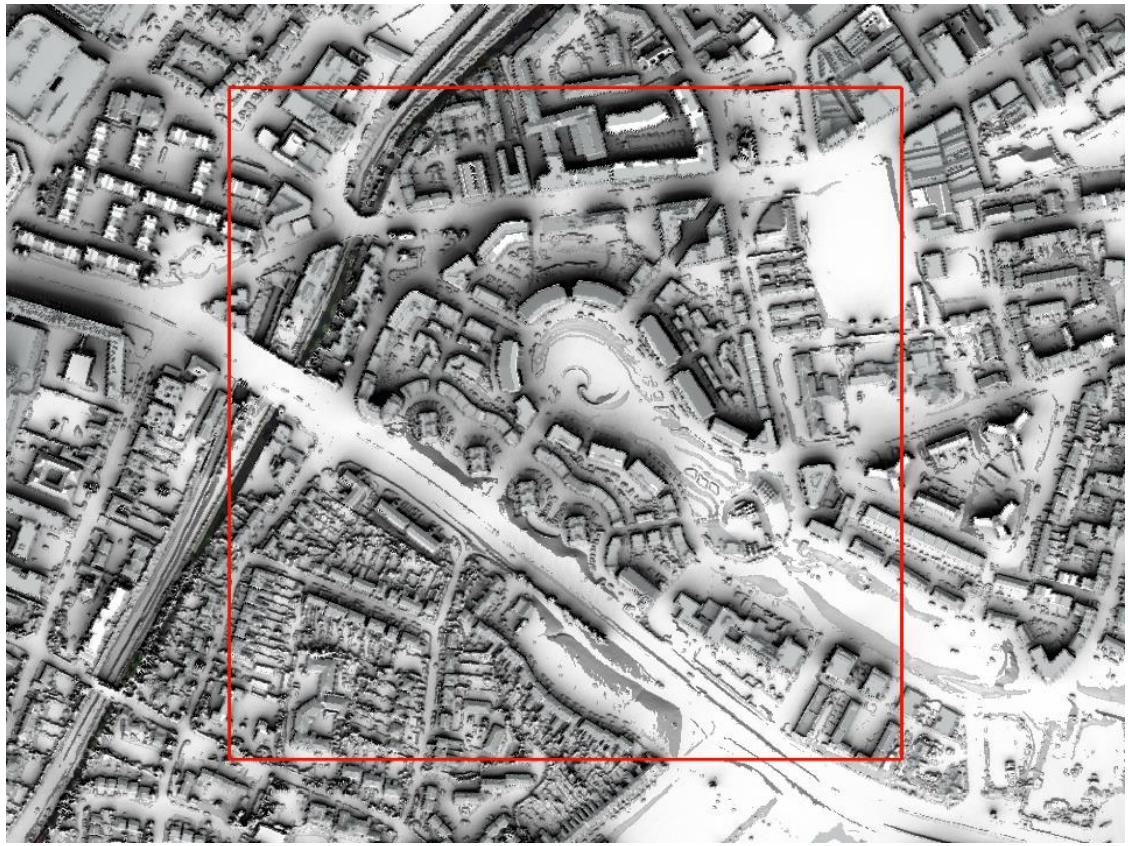


Source: The Legacy of Heat Roadmap Europe 4

Problem

Pre-feasibility DHC studies are expensive, take time, and rely on uneven approaches, leading public authorities to face growing challenges to effectively manage their energy planning tasks.

The needs of local authorities



- Consistency in approaches
- Comparability of results
- Information about methodologies used
- Time and cost efficiencies

- **Robust methodologies and tools to rapidly identify, analyse and compare specific thermal energy system option**

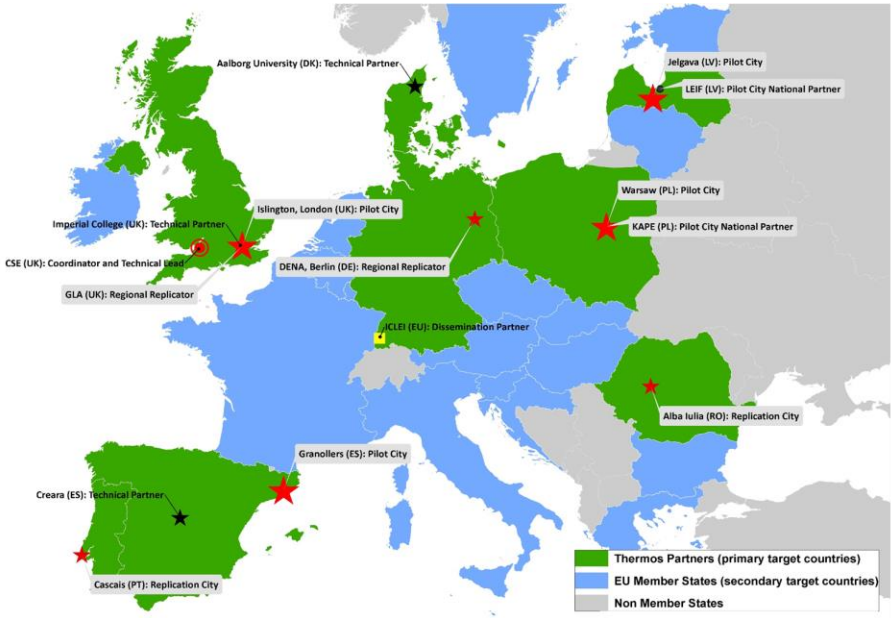
- **Building capacity in public authorities responsible for energy planning is essential to develop strategic local sustainable energy solutions.**

The THERMOS solution

- An open-source web-based software application
- A standardised approach for
  - methods
  - data
  - tools
- Developed in collaboration with the final users
- Allowing sophisticated thermal energy system planning far more **rapidly** and **cheaply** than they can today

Source: …

THERMOS consortium



- Brings together research, consulting and multiplier organisations with local, regional and national authorities - the final users
- Provides for development, validation and exploitation

THERMOS

centre for sustainable energy

An introduction to the THERMOS application

Joshua Thumim, Centre for Sustainable Energy, Bristol, UK

IDEA 2019, Pittsburgh, 25 June 2019

Aims of this presentation

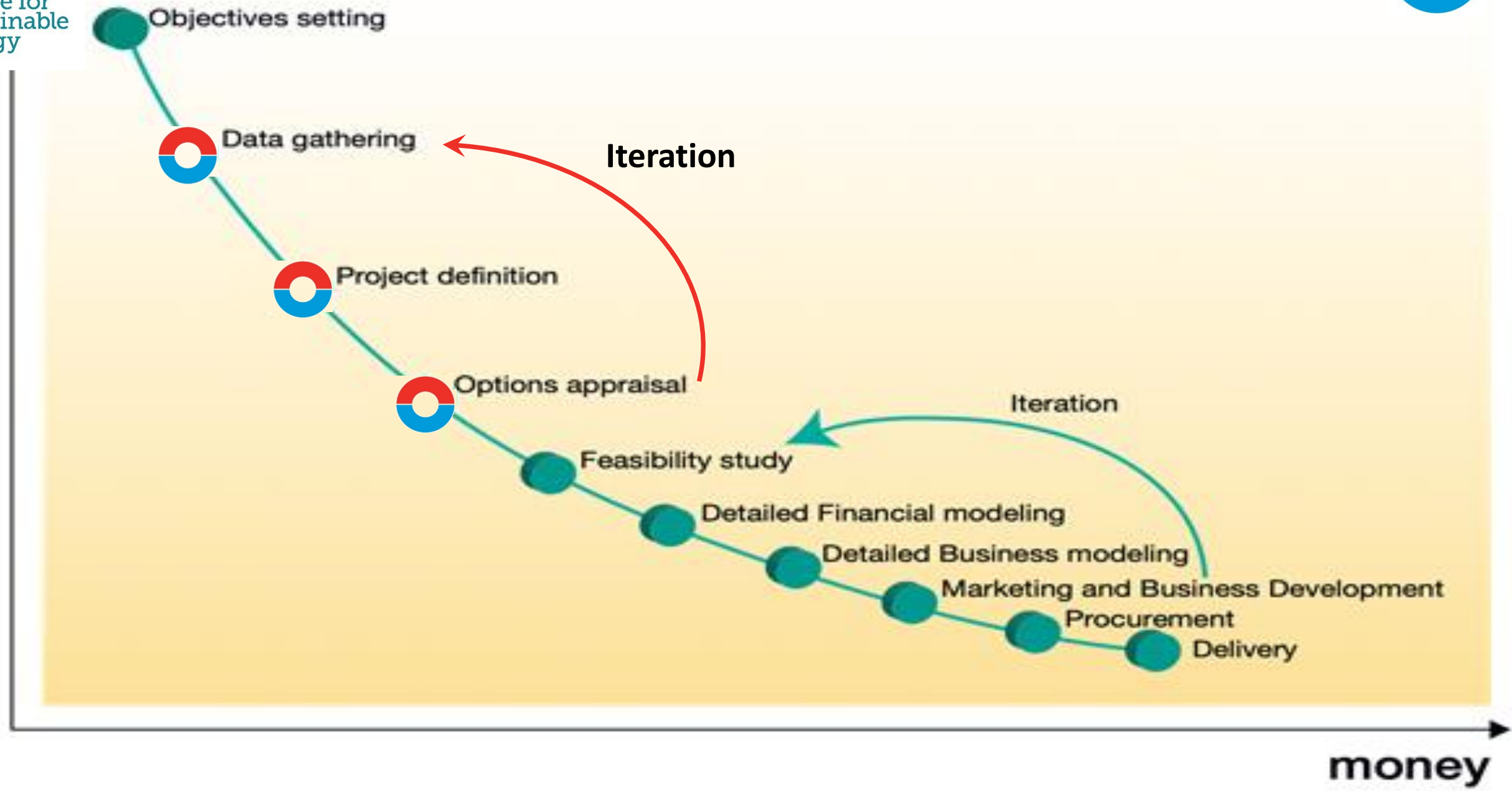
- Share our excitement about THERMOS!
- Offer you an insight into the problems we have solved, and how the solutions may be valuable to you in your work
- Hopefully build on this to develop connections with potential users

Structure

1. **What is THERMOS?**
   - A THERMOS solution
   - A THERMOS problem
   - Making maps
2. **Technical details**
   - What is being optimised?
   - What is represented in the model?
   - How do we estimate building demands?
3. **Features in the pipeline**
4. **How can THERMOS add value?**

What is THERMOS?

- "Thermal Energy Resource Modelling and Optimisation System"
- Web-based software for detailed pre-feasibility analysis of heating and cooling network options
- Designed to support project development from area-wide mapping and masterplanning, through to detailed consideration of optimal network layouts


Objectives setting
Data gathering
Project definition
Options appraisal
Feasibility study
Detailed Financial modeling
Detailed Business modeling
Marketing and Business Development
Procurement
Delivery
Iteration
Iteration
money

What does THERMOS tell you?

- A THERMOS solution is a sized and costed geographic and topological description of a heat distribution network (cooling is coming later this year):
  - Supply sites and sizes
  - Pipe sizes, routes and connectivity
  - Connected demands, sizes and peaks
  - Revenues, Costs -> NPV
- The solution maximises NPV given the inputs
- Other objectives and constraints are in the pipeline

What does a solution look like?

Map | Options | Result | Help | THERMOS | Downtown Network Problem | Save | Optimise ▸

252 candidates selected

- 18 Wharton Street ×
- 8 Merriman Way ×
- 2 Franklin Court ×
- 2 South 16th Street ×

Length	2.157 km
Base cost	873.678 k¤
Demand	3.094 GWh/yr
Peak	3.305 MWp
In solution	252 yes ×
Coincidence	85.192 %
Capacity	2.049 MW
Diameter	113.317 mm
Principal	2.149 M¤
Revenue	278.476 k¤/yr
Losses	381.576 MWh/yr, NaNW/m

Name	Wh/yr	Wp	¤	Type	Class	In?
			1.293 k	path	Connector	✓
	46.282 M	44.81 k	0	building	Commercial	✓

1 filter applied, showing 252 of 398 candidates. CLEAR FILTERS

And what does a problem look like?

Map | Options | Help | THERMOS | Downtown Network Problem | Save | Optimise ▸

1 candidate selected

Type	1 building ×
Classification	1 Unclassified ×
Constraint	1 optional ×
Name	1 None ×
Base cost	1.288 k¤
Demand	7.901 MWh/yr
Peak	25.761 kWp

Name	Wh/yr	Wp	¤	Type	Class
			1.293 k	path	Connector
	46.282 M	44.81 k	0	building	Commercial
			269.685	path	Connector

Repeatedly solve this, while increasing the heat sale price:

Making the maps

- THERMOS includes features to enable you to create a map for the area you are interested in
- You need to do this before you can define and solve problems
- Maps can be created either automatically from OpenStreetMap, or from your own shapefiles
- Demand estimates can be calculated automatically based on 3D building geometries (assuming LIDAR is available), or you can provide your own values in the shapefiles

Recap

- THERMOS computes optimal layouts for heat networks
- You specify which buildings and routes are either *allowed* or *required* to be in the solution, and the location(s) at which heat supply can be provided
- Solution times vary with complexity, but problems comprising hundreds of buildings can be solved in seconds or minutes (remember that for 100 buildings there are approximately 10^{30} distinct sets, so this cannot be done by hand)
- THERMOS can be applied anywhere there is appropriate mapping data available – either provided by the user, or imported directly from OSM
- The system incorporates a demand-estimation method based on building geometries. This requires LIDAR coverage for 3D features.

Detail: what is being optimised?

- THERMOS optimises a model of a heat network, maximising NPV by deciding:
  - For each place where a pipe could go, whether a pipe should be there
  - For each place with demand, whether to meet the demand
  - For each place where a supply could go, whether to put a supply there
- Given these choices, it then decides:
  - For each pipe, how large the pipe has to be
  - For each supply, what the supply capacity has to be
- From this the costs and revenues are calculated

Detail: what is being modelled?

- The network model accounts for:
  - Annual and peak demands on buildings
  - Pipe capacity @ ΔT=> Pipe diameter => Installed pipe cost
  - Heat losses from the network
  - Pumping costs
  - Load diversity in the network
  - Heat supply cost
  - Heat sale price
  - Amount and value of emissions associated with supply
  - Amount and value of counterfactual emissions

Features in the pipeline

- Supply optimiser
- Cooling network model
- More objectives and constraints
- UI enhancements
- Counterfactual comparisons

Where does THERMOS create value?

1. Better network design at the prefeasibility stage – current practice does not identify optimal solutions
2. Significantly faster and cheaper assessment of options, so many more options are considered, at greatly reduced cost
3. Enables analysis of the sensitivity of the optimal network design to a range of assumptions (supply cost, heat sale price, cost of finance, etc.)
4. All of this means reduced risk of wasted time at detailed design stages
5. Automation of mapping processes eliminates time and cost to get started – anywhere in the world
6. Browser based application – no local deployment, easy
7. Our goal: accelerated rollout of the right thermal networks in the right places, leading to carbon emissions reductions.

Try THERMOS for yourself…

- Read more about the project at www.thermos-project.eu
- Read the user manual (not yet complete) at https://v5.thermos-project.eu/help/index.html
- in particular look at the quick start quide at https://v5.thermos-project.eu/help/quick-start.html
- And finally, test the application for free by visiting https://v5.thermos-project.eu and creating an account

centre for sustainable energy

thermos-project.eu

Thanks for listening!

Joshua Thumim
Head of Research and Analysis
Centre for Sustainable Energy, Bristol, UK
THERMOS Project Coordinator

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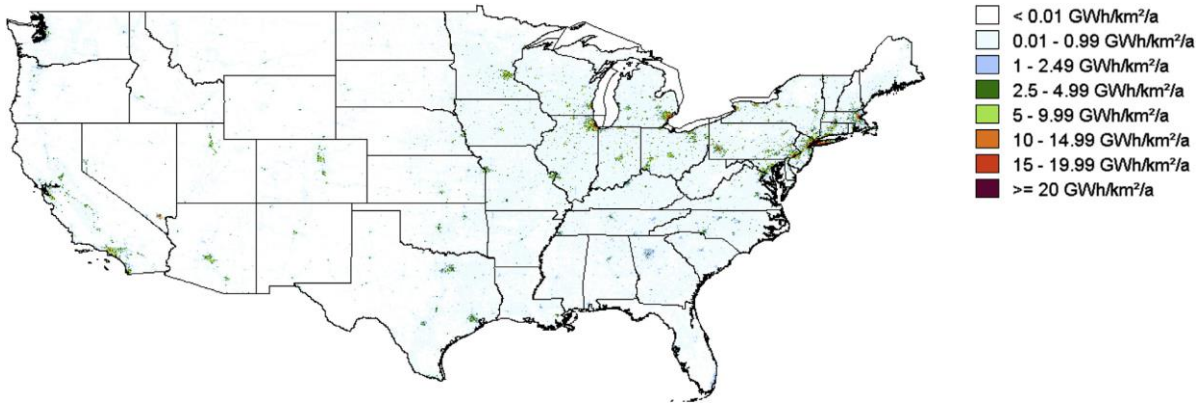
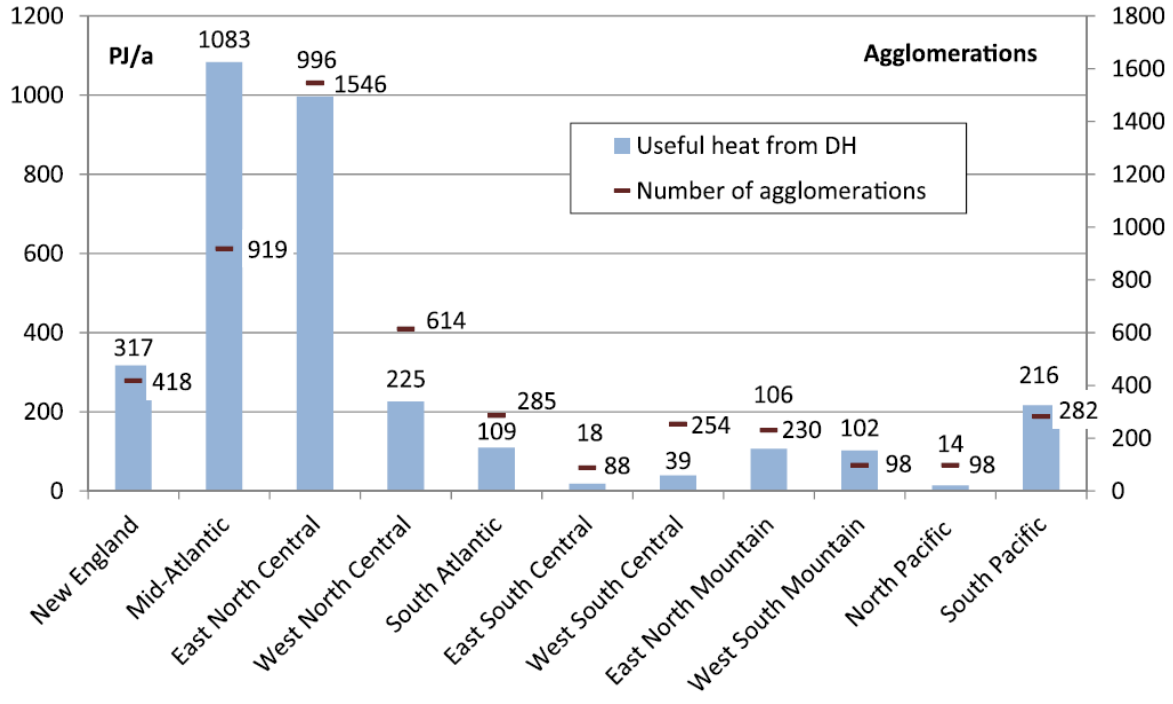
Data analysis tools for DHC planning

Alastair Robinson, Berkeley National Lab

IDEA 2019, Pittsburgh, 25 June 2019

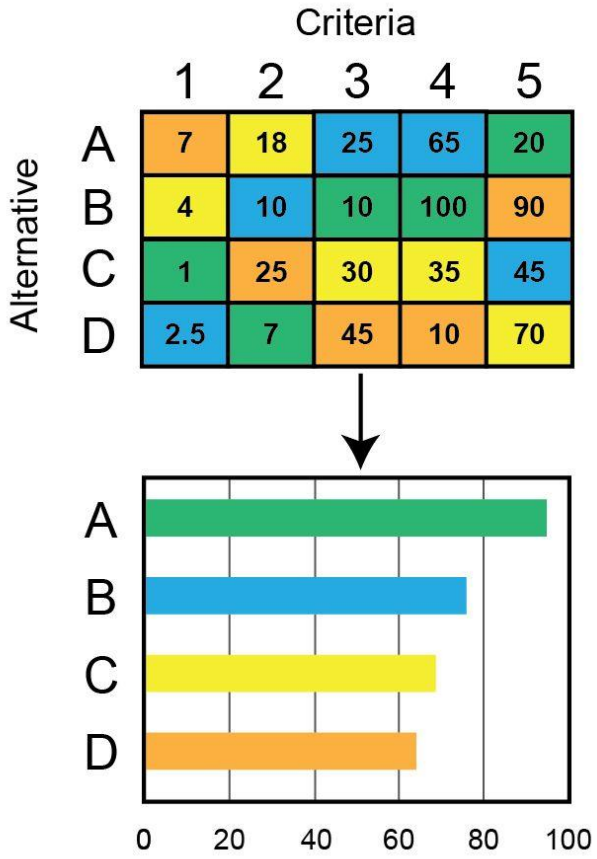
The (Heating and Hot Water) Opportunity





Source: Gils et al (2013)

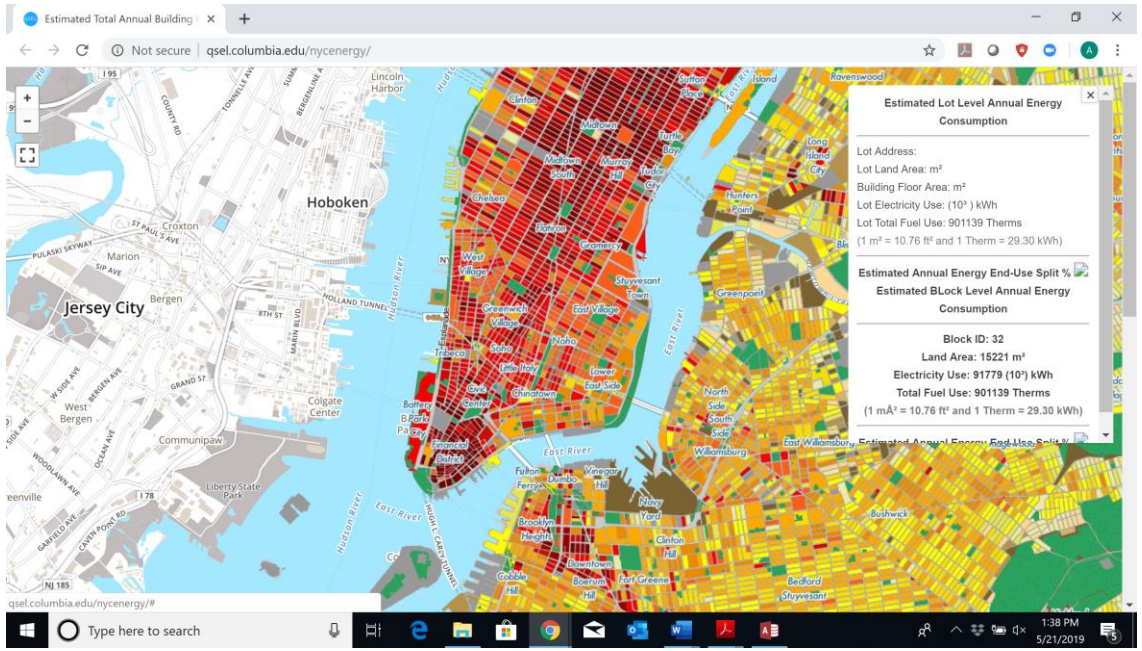
Defining an Energy Infrastructure Project

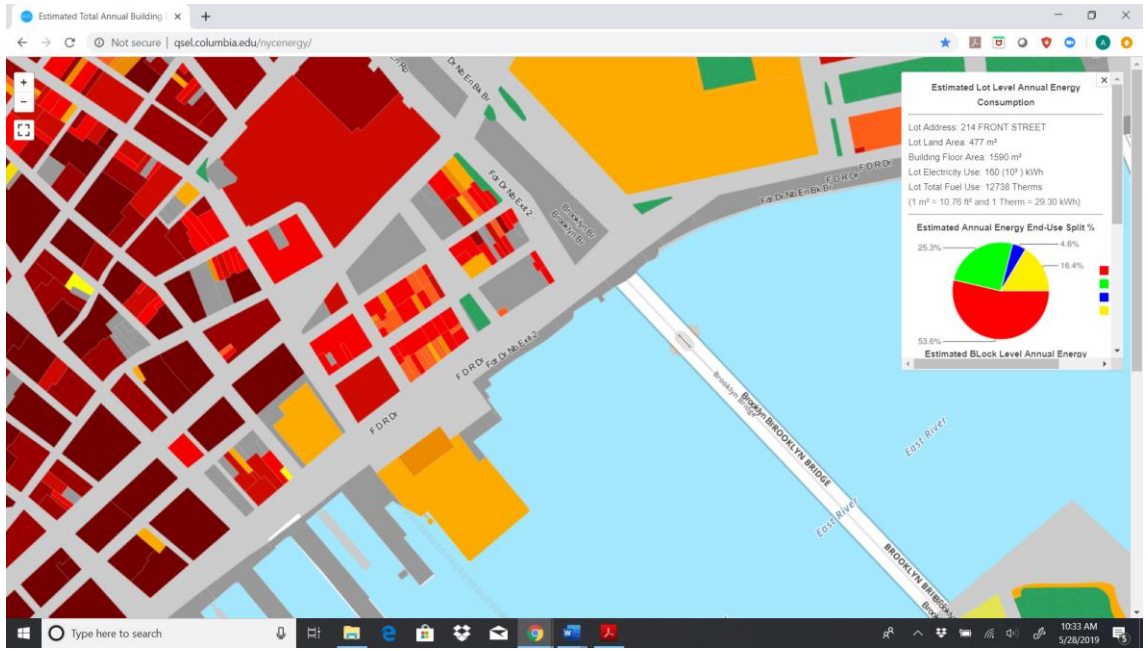


- Multi Criteria Decision Analysis
  - Supports value judgement-based assessment of multiple (wide-ranging or otherwise) solutions for a specific scenario
  - Allows a range of criteria to be represented, regardless of perceived relevance / impact
  - Robust, completely transparent process
  - Designed to identify preferences using inputs from a multitude of disparate perspectives

Source: …

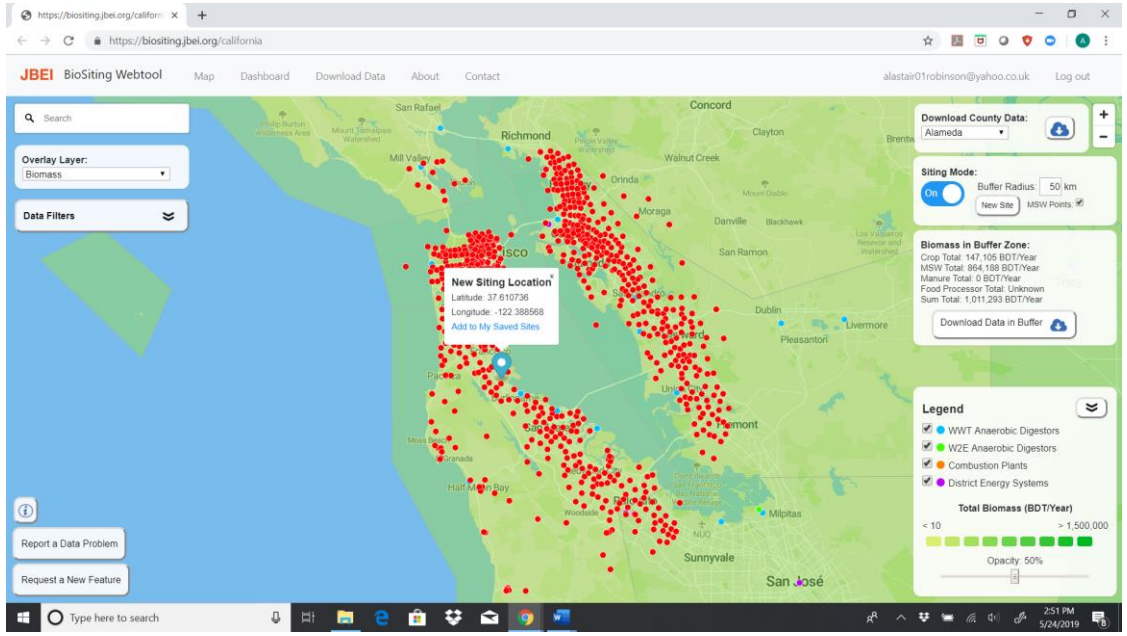
Energy Data Representation

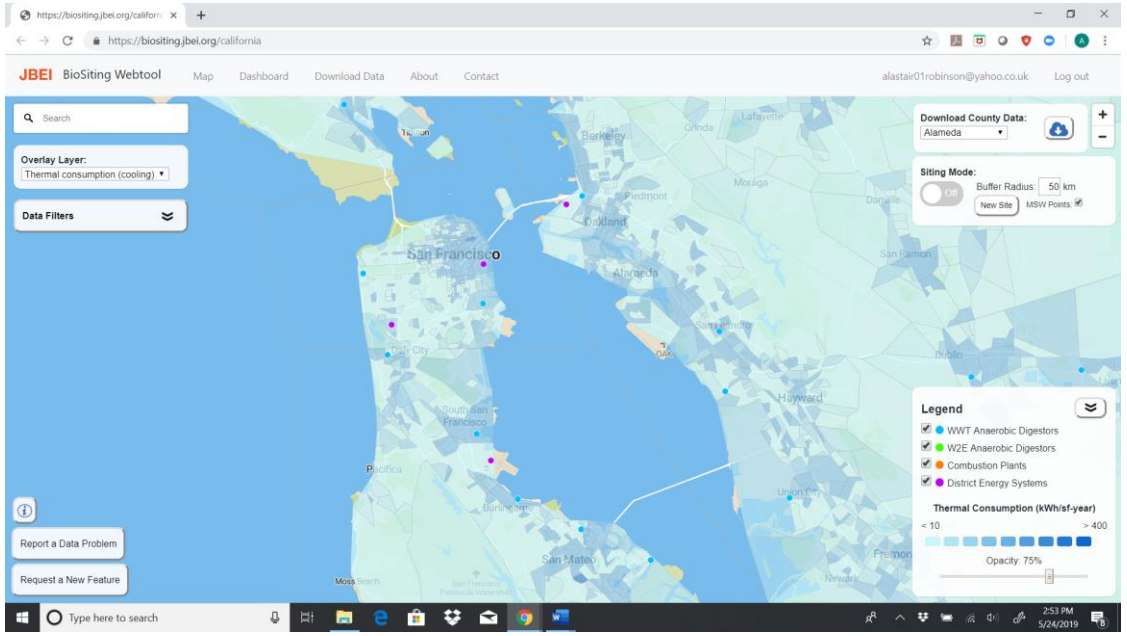




Source: Modi Research Group, Columbia University, http://qsel.columbia.edu/nycenergy/

Project Objective-based Mapping





Source: Lawrence Berkeley National Laboratory, https://biositing.jbei.org/

Towards Comprehensive Tools

- Commencing an assessment of current publicly available tools for DOE-AMO
- Identify and evaluate existing software tools
- Identify strengths and weaknesses in project development ‘chain’.
- Review relevant current initiatives and projects
- Identify gaps in and provide recommendations for additional publicly available materials, tools, and software.
- Propose outline specifications for tools needed to fill identified gaps
- **Obtaining feedback and input from industry and relevant stakeholders (e.g. planning and policy, industry practitioners, project financiers) vital to overall process**

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