



NREL's Urban Scale Analysis / URBANopt

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IBPSA Project 1 Meeting



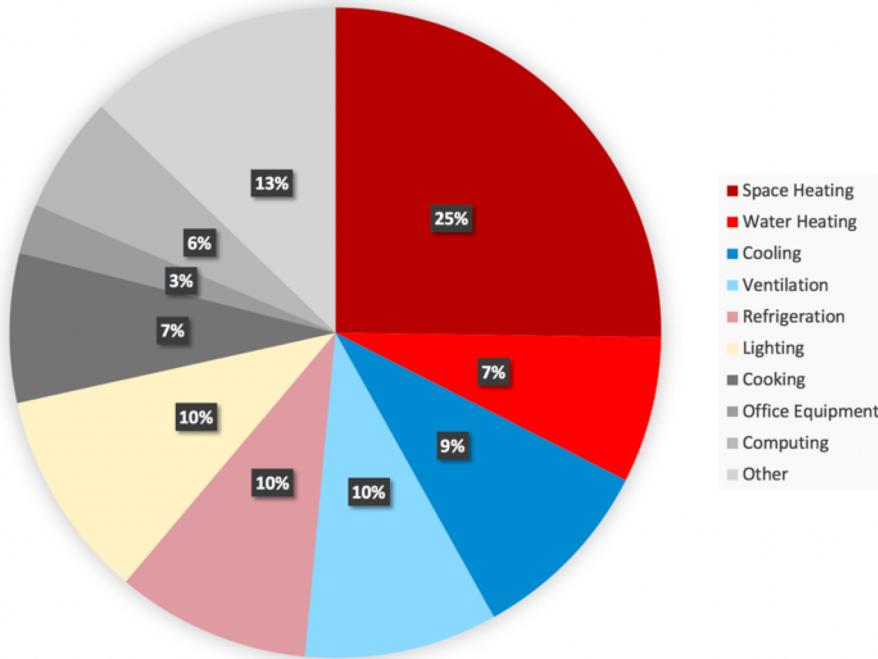
Motivation

Why focus on 5GDHC?

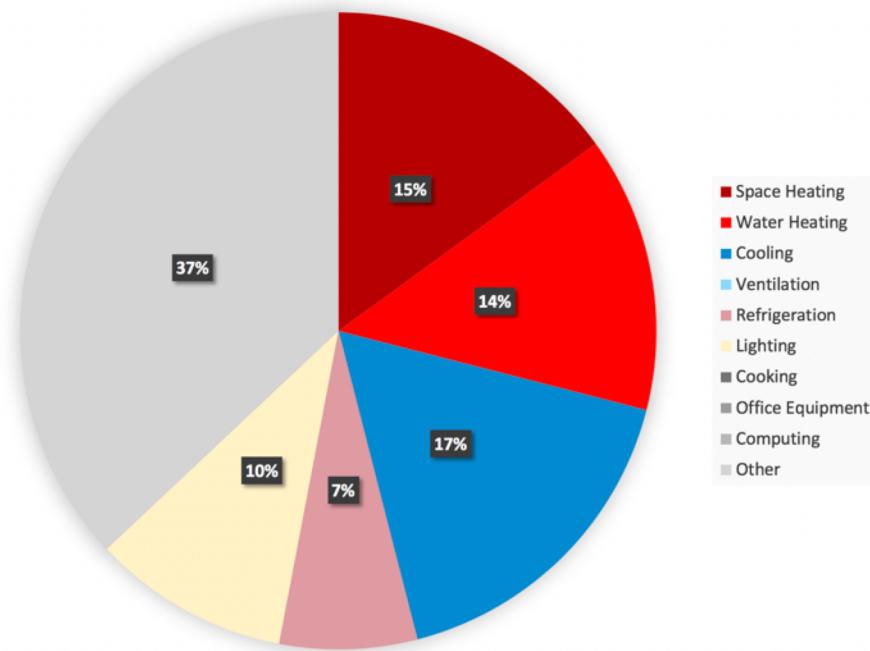
- District heating and cooling has little penetration in the United States
- Running district heating and cooling at near ambient temperature would allow for new heat sources to be used (e.g. waste water treatment, data centers, refrigeration, etc.).
- There are no tools available for quickly evaluating these new systems

USA - Current Building Energy Use

Commercial



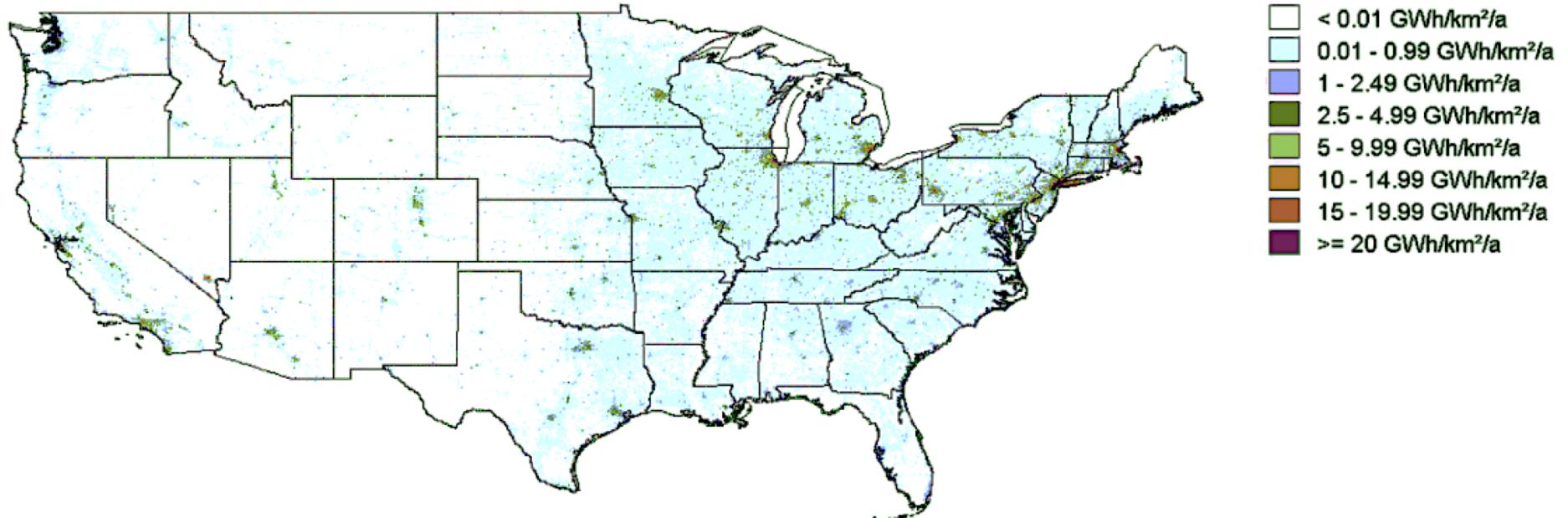
Residential



Source: EIA (Energy Information Administration), "Commercial Buildings Energy Consumption Survey (CBECS)," tech. rep., Department of Energy (DOE), 2012.

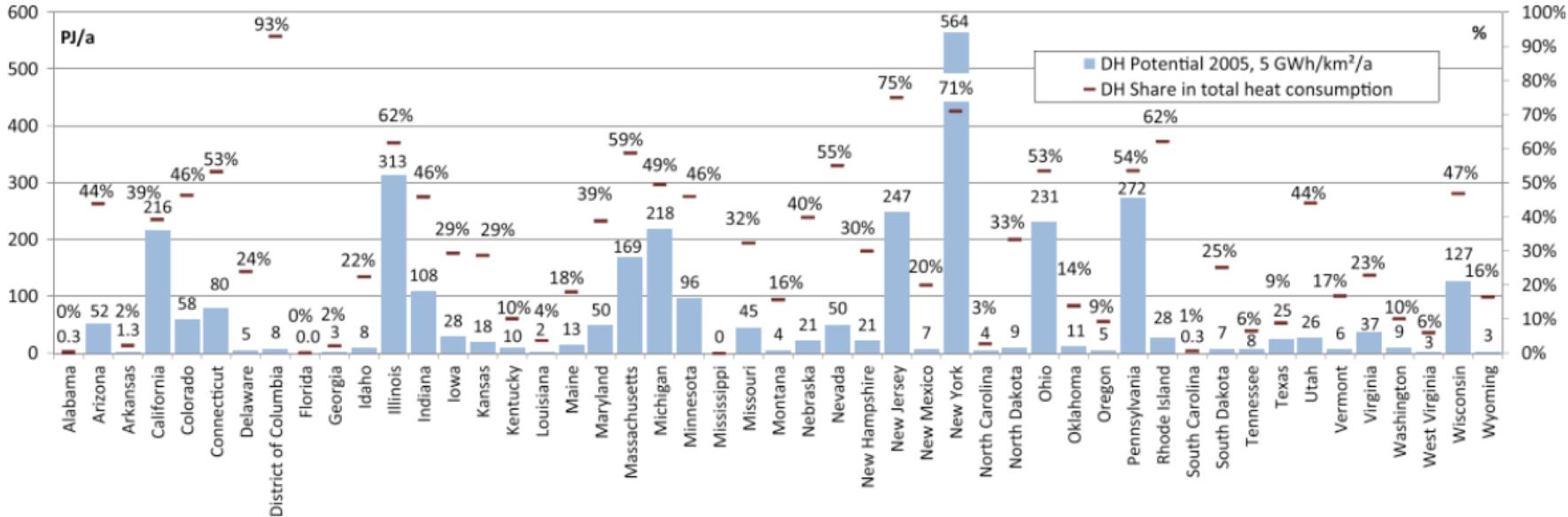
Source: EIA (Energy Information Administration), "Residential Energy Consumption Survey (RECS)," tech. rep., Department of Energy (DOE), 2015.

District Heating Density



Source: Gilis, GIS-Based Assessment of the District Heating Potential in the USA

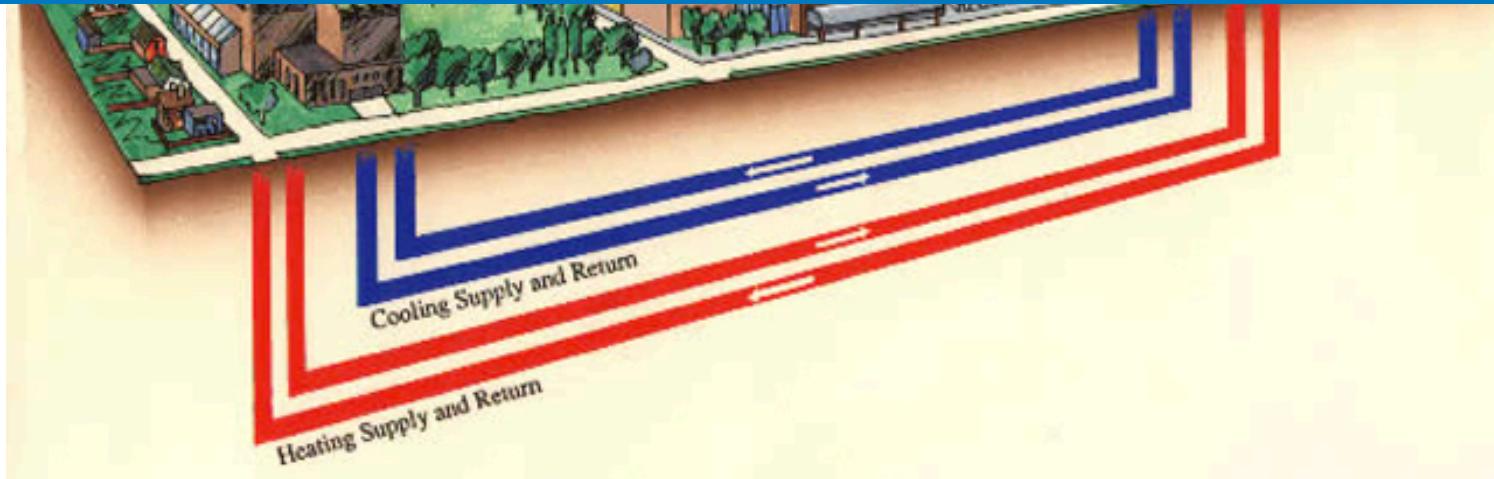
District Heating Potential



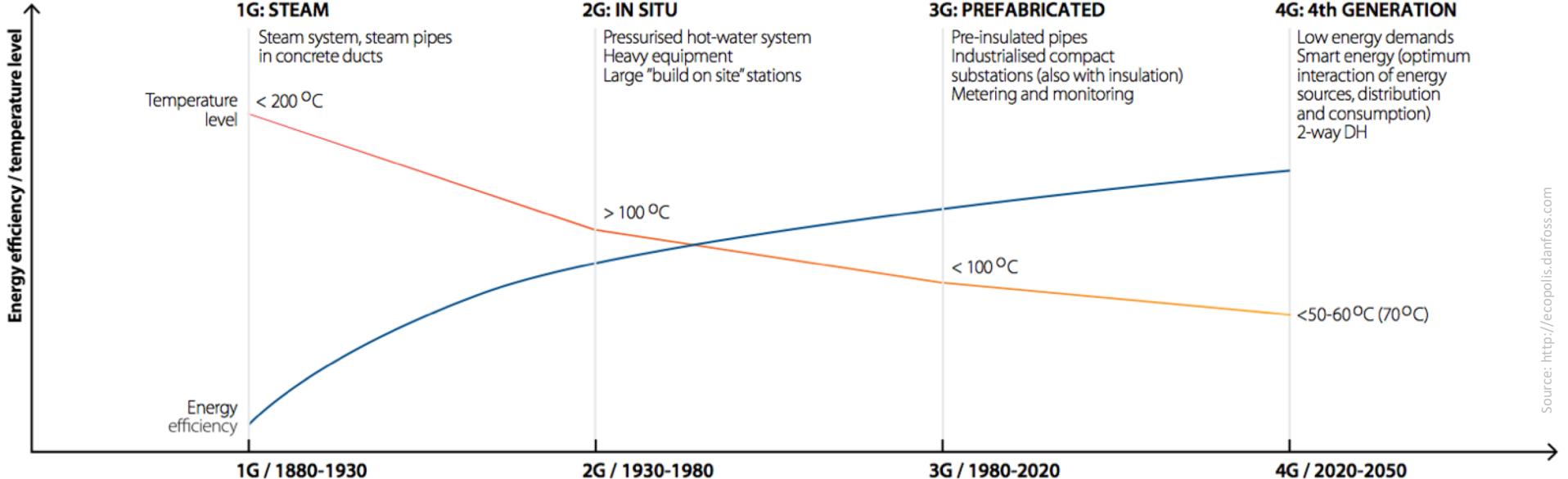
Source: Gilis, GIS-Based Assessment of the District Heating Potential in the USA



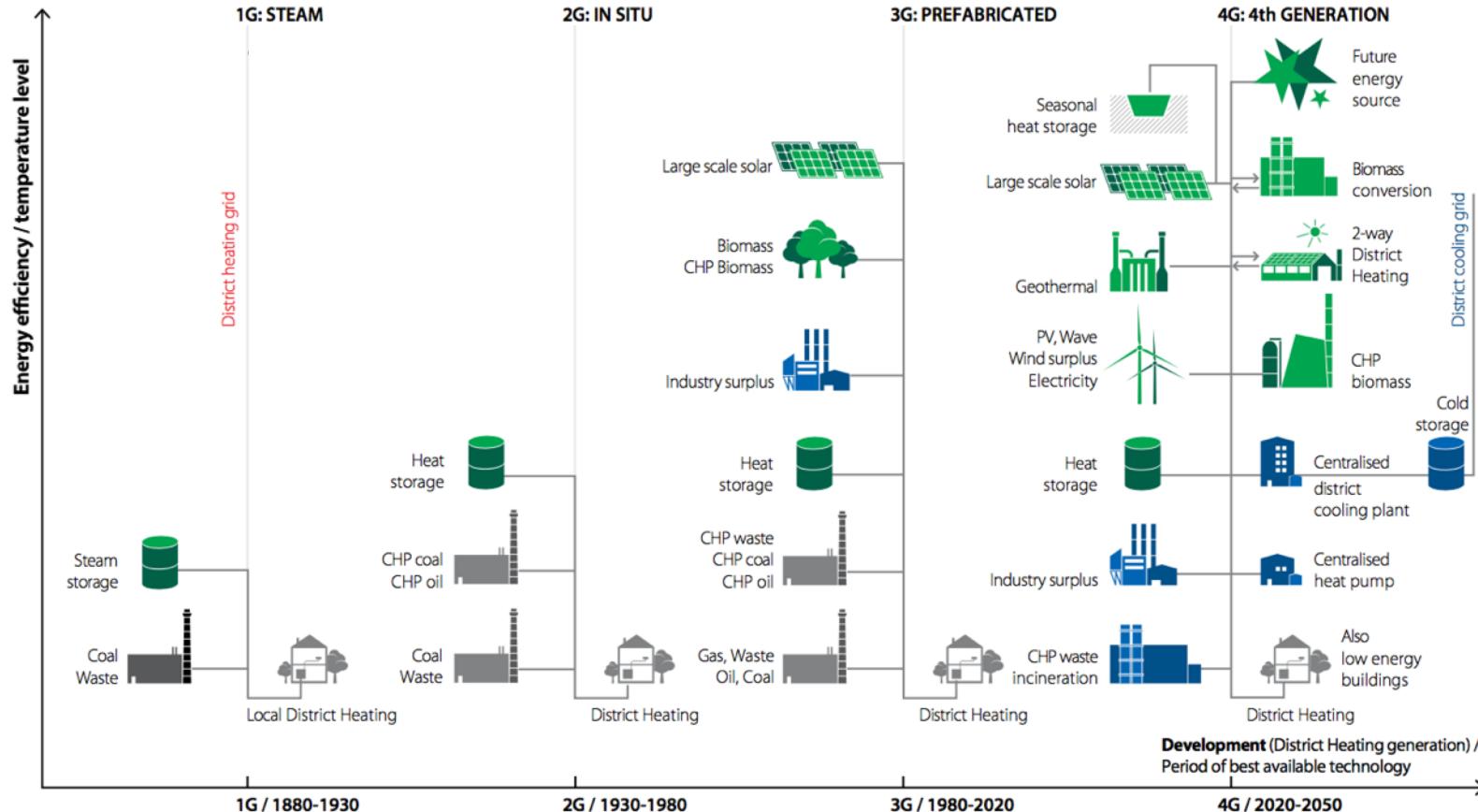
District Heating and Cooling Systems



District Heating and Cooling



District Heating and Cooling



Source: <http://ecopolis.danfoss.com>

Motivation - URBAOpt

The screenshot shows the URBAOpt software interface. On the left is a sidebar with tools: File, Select (highlighted in blue), Draw, Resize, Rotate, Move, Zoom to Features, and Map Settings. The main area has two maps: a 2D plan view and a 3D perspective view of a campus. The plan view shows green buildings and grey roads. The 3D view shows the same scene with buildings as 3D blocks. Below the maps is a table of Building Properties:

Name	Building Type	Floor Area	Num Stories	Num Above	Building Stat.	Include in En.	Exclude HVA.	Year Built	Footprint Area	Footprint Per%	Maximum Ro%	Mixed
Energy Systems Integration Fac...	Office	296826.11368...	3	3					98942.03789...	2193.238784...	30	
Education Center	Office	7012.8725886...	1	1					7012.872588...	431.8784100...	10	
East Entry	Office	869.89212621...	1	1					869.8921262...	133.9269985...	10	
Research Support Facility	Office	405451.76968...	4	4					101362.9424...	3325.856997...	40	
Science and Technology Facility	Office	148624.32740...	3	3					49541.44246...	1317.364337...	30	
Solar Energy Research Facility	Office	129822.68155...	2	2					64911.34077...	1561.085792...	20	
Cafe	Food service	10476.075491...	1	1					10476.07549...	518.8919731...	10	

Motivation - URBAOpt

The screenshot shows the URBAOpt software interface. On the left is a map of a facility area with various buildings and roads labeled. A specific building is selected, and its properties are displayed in a modal window:

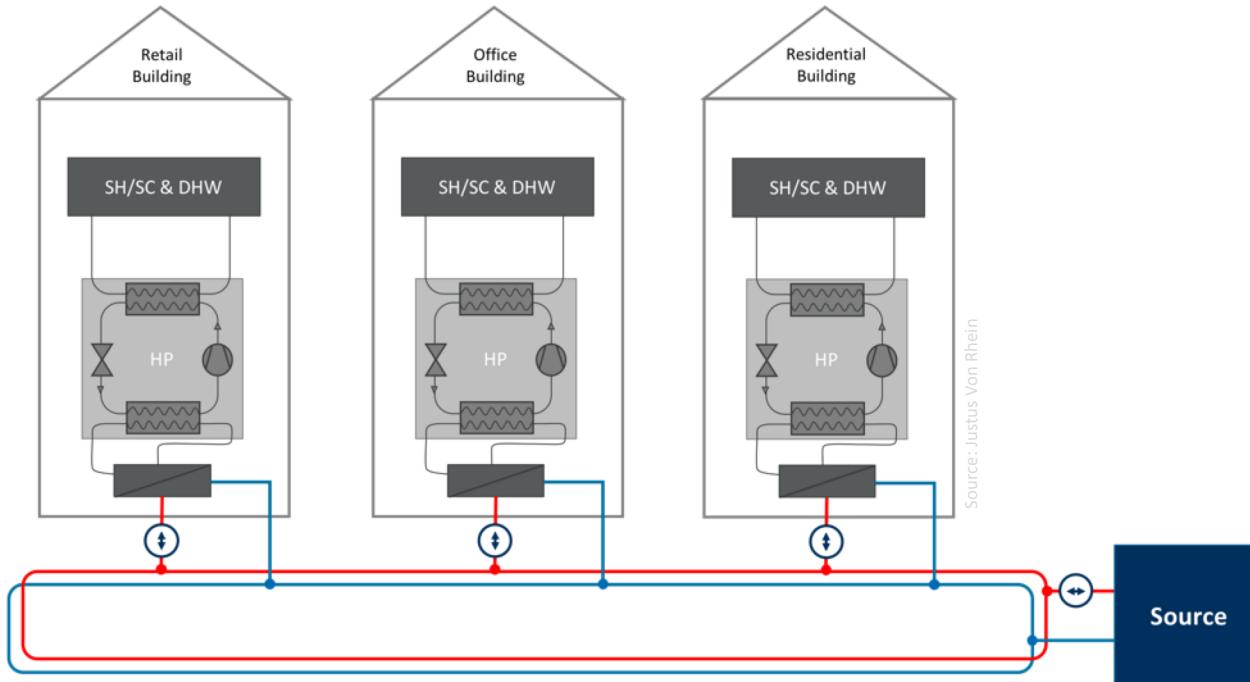
maximum_roof_ht	40
floor_area	405451.76968951966
number_of_stories	4
number_of_stories	4
source_id	Research Support Faci
source_name	NREL_GDS

Below the modal are buttons for '+ Add row', 'Show style properties', 'Properties', 'Info', 'Save', 'Cancel', and 'Delete feature'.

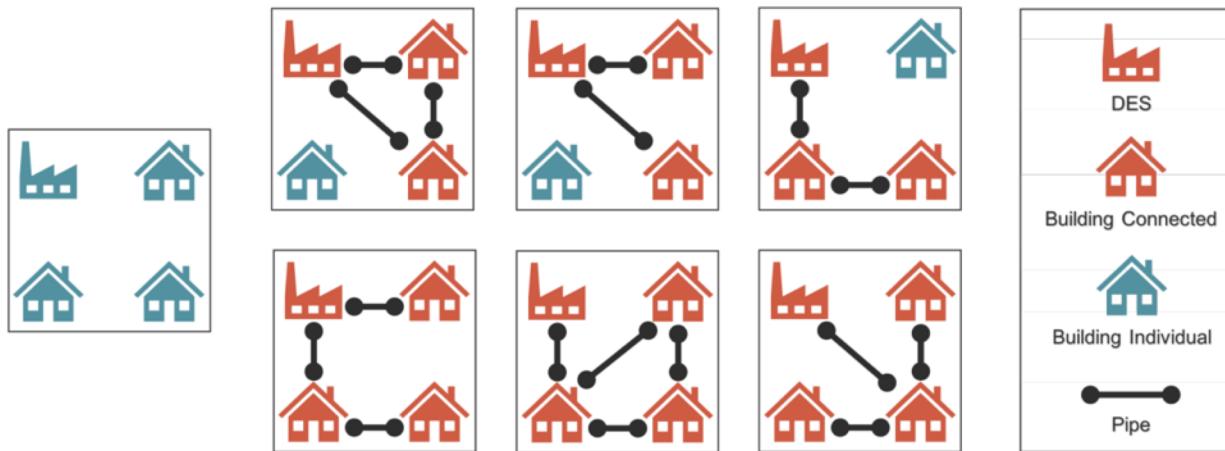
To the right of the map is a JSON editor window titled 'JSON' with the following schema:

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2   "type": "FeatureCollection",  
3   "features": [  
4     {  
5       "type": "Feature",  
6       "properties": {  
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9         "stroke-opacity": 1,  
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14        "floor_area": 296826.11368011055,  
15        "number_of_stories": 3,  
16        "number_of_stories_above_ground": 3,  
17        "source_id": "Energy Systems Integration Facility",  
18        "source_name": "NREL_GDS",  
19        "building_type": "Office",  
20        "surface_elevation": 5198,  
21        "name": "Building"  
22      }  
23    }  
24  ]  
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5GDHC – Distributed Heat Pump

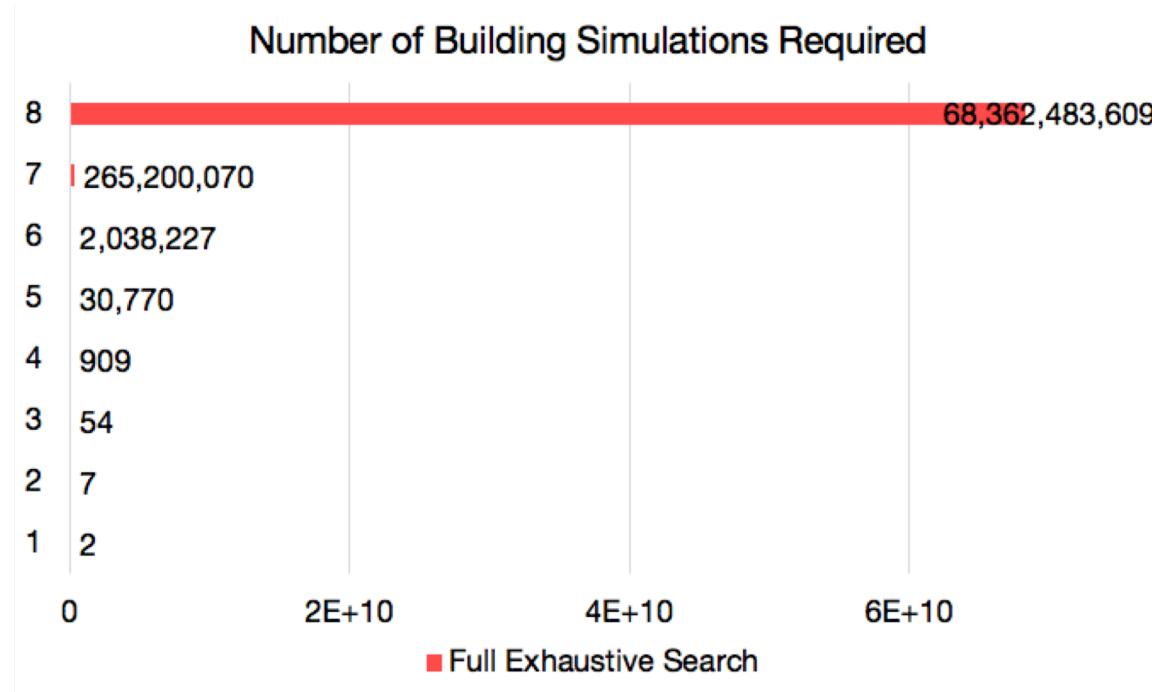


Topology Design

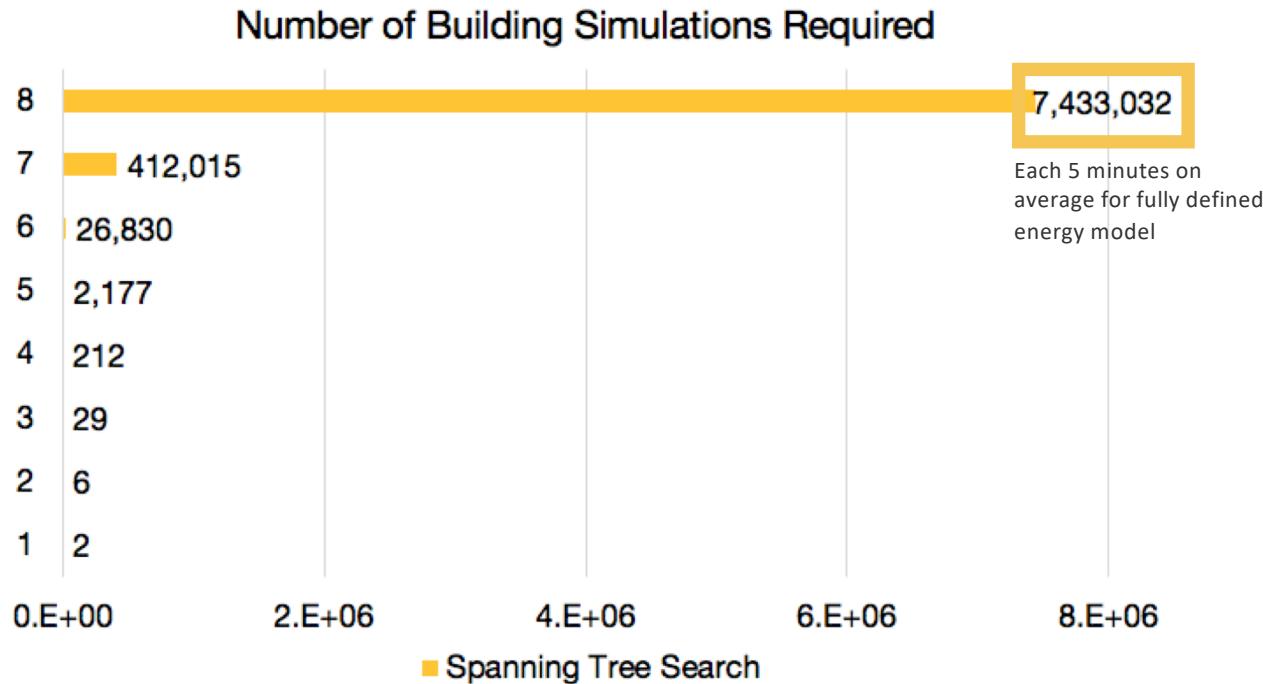


- 4 Prosumers – 53 Combinations
- 8 Prosumers – 68 Trillion Combinations

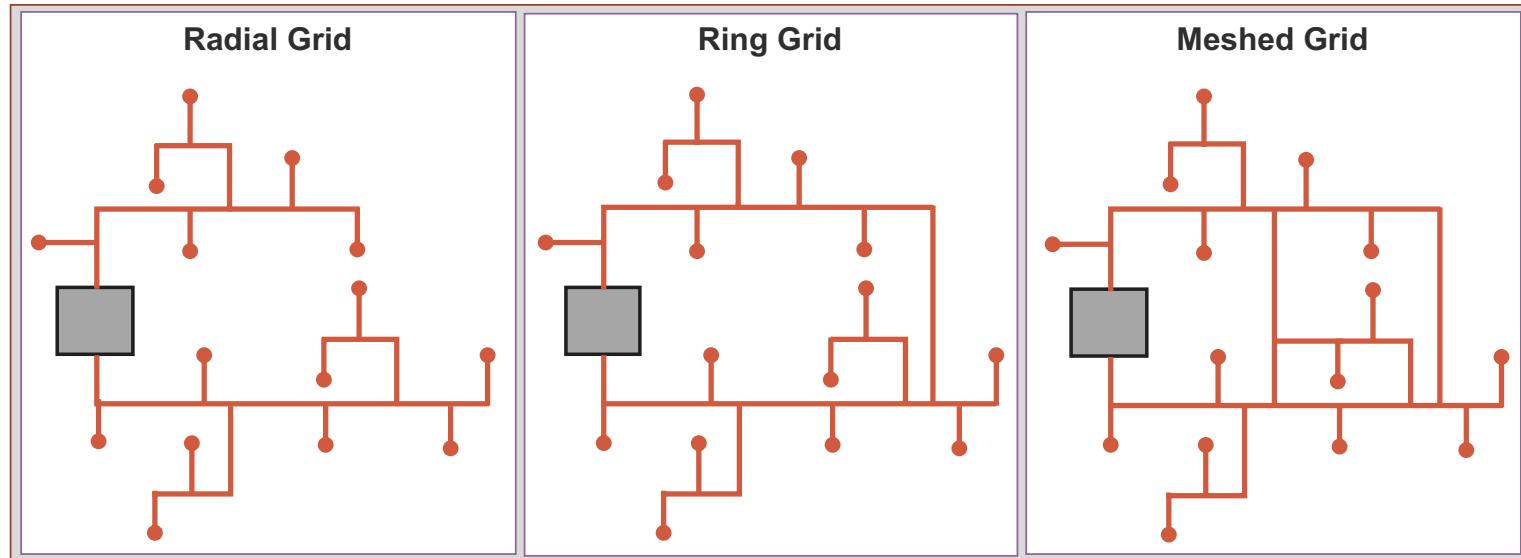
Topology Optimization of 5GDHC Network



Topology Optimization of 5GDHC Network

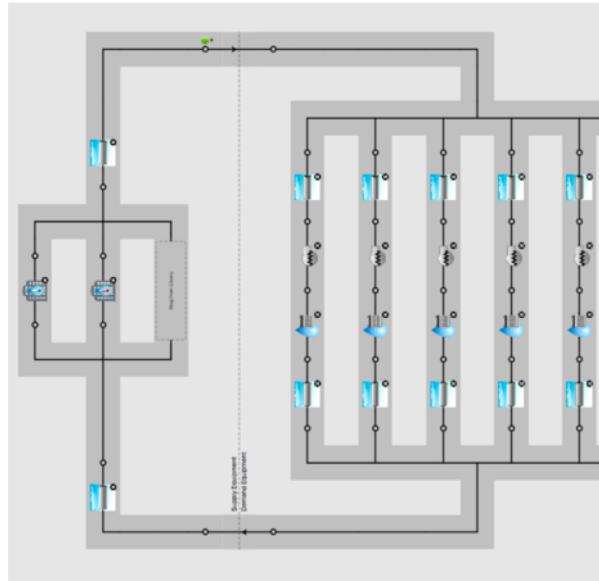


Design Aspects for 5GDHC

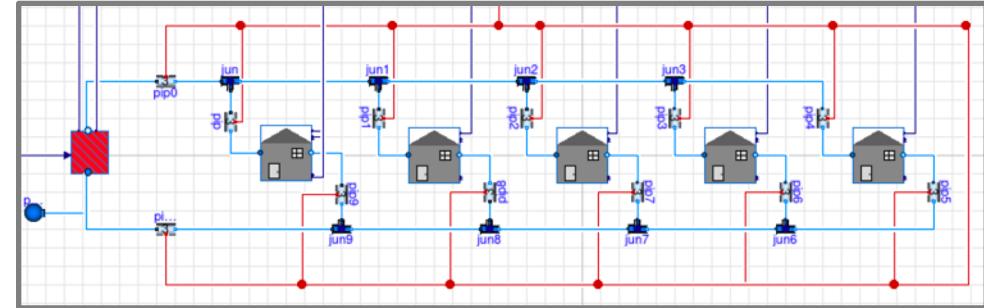


Modeling District Systems

- Simple modeling in EnergyPlus/OpenStudio
 - Comprehensive modeling using Modelica



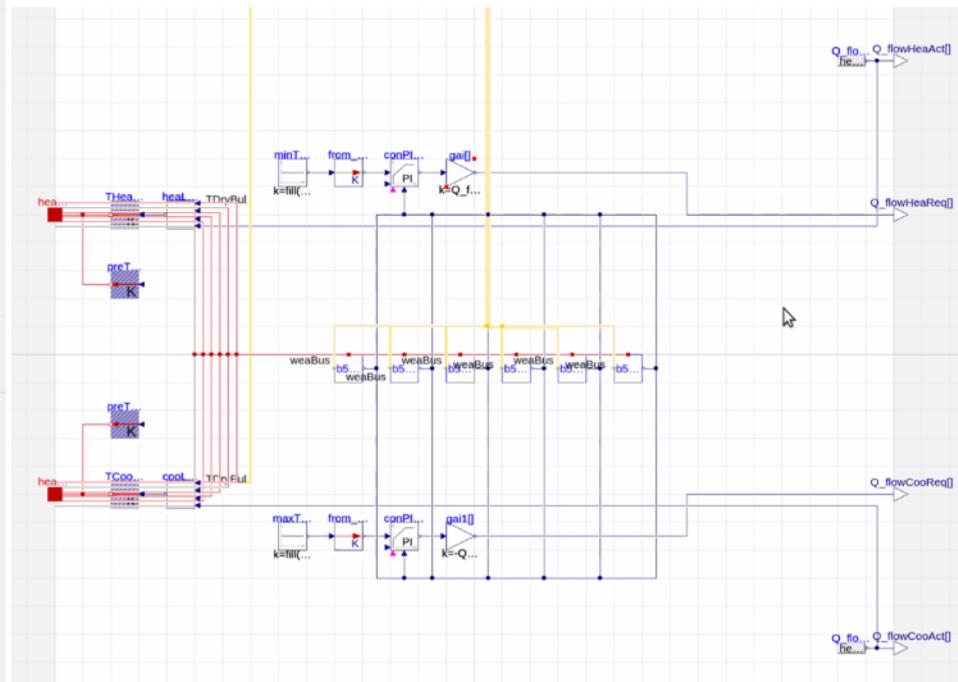
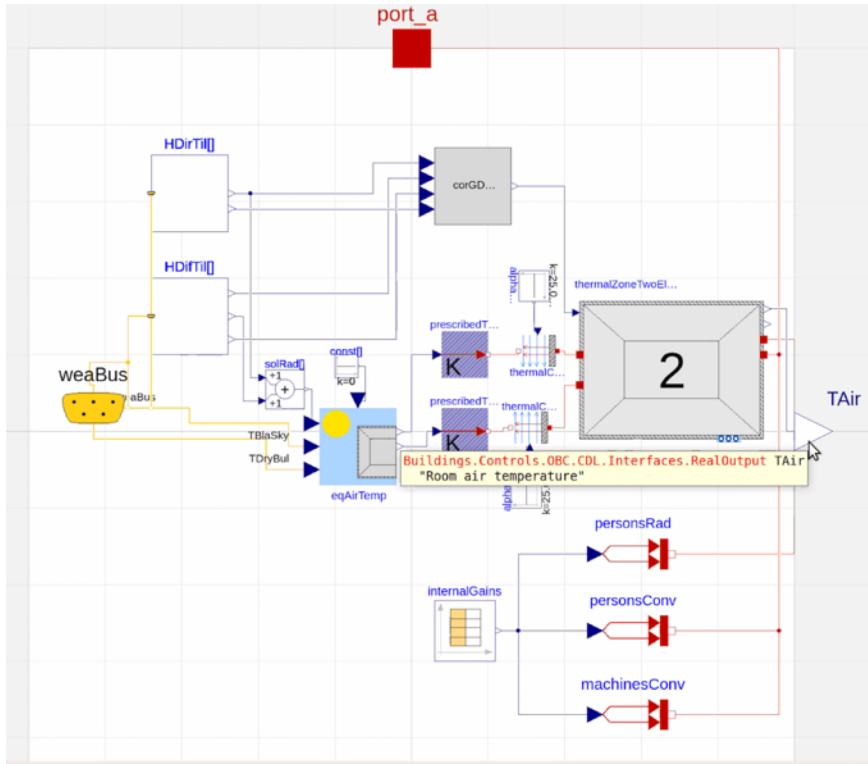
EnergyPlus



Modelica

Modelica RC Models

- Use the Building's Library RC exported from TEASER



Thank you!

Questions?

www.nrel.gov

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