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An Innovative Software Tool for Non-technical Users to Identify Business Opportunities for District Energy and Community Microgrids

Gavin Dillingham, Ph.D. and Carlos Gamarra, P.E., PhD

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ABOUT THE PROJECT

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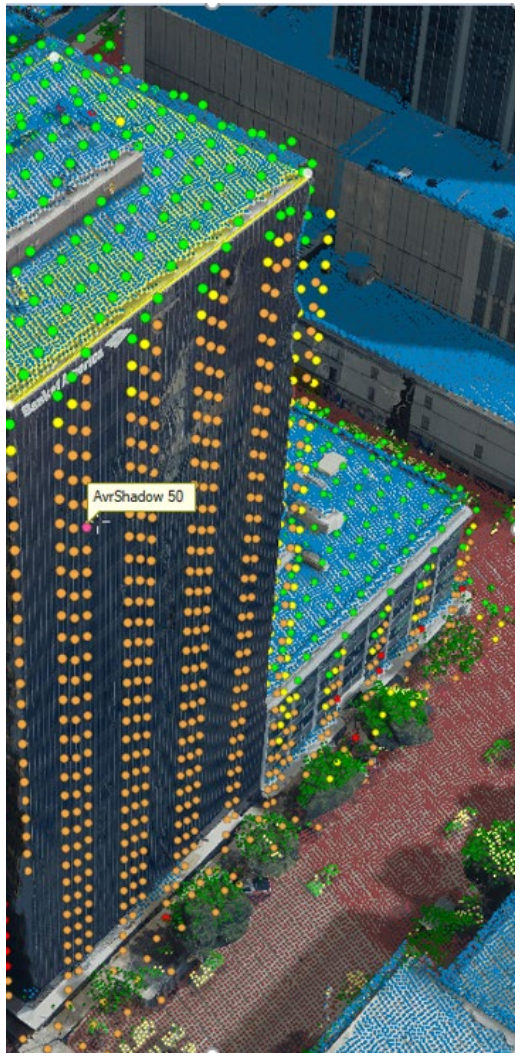

- Software tool development project oriented to feasibility analyses (FAs) for district energy and community microgrids
- Funder: DOE's Advanced Manufacturing Office
- Duration: 09/2020 -11/2023
- Lead by HARC, partnering with UH and Fugro

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PROBLEM DESCRIPTION

QUALITY AND QUANTITY ISSUES

PROBLEM RATIONALE: QUANTITY ISSUE

- District energy and community microgrids have the potential to provide resilience and decarbonize.
  But do they have the potential to fulfill the financial goals of their investors?
- Investing is a complex decision due to the high initial investment and risks associated with the long project lifecycle.
- The number of FAs developed is limited by the low level of independence investors have.
  - TECHNICAL BARRIERS : lack of expertise on how to configure the systems and how that configuration would affect the economics.
  - ECONOMIC BARRIERS: low interest in spending money (>$100K) on studying solutions that might be feasible, or not.
- **More feasibility analyses would lead to an increasing adoption of community microgrids and district energy systems.**

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PROBLEM RATIONALE: QUALITY ISSUE

- Singularities of FA for community microgrids and district energy systems
  - Investors are rarely involved at this stage due to their lack of technical expertise, but are always interviewed about their goals
  - **HIGH NUMBER OF POTENTIAL SOLUTIONS**: Each microgrid project has dozens of potential combinations of technologies, sizes and manufacturers. Power or thermal distribution system planning adds complexity.

$$MaxPL = \sum_{i=1}^{N} (N - i) = \frac{N^2 - N}{2} = \frac{6^2 - 6}{2} = 15 \qquad Search\ Space\ Size = s^{MaxPL} = 3^{15} = 14{,}384{,}907$$

  - **TIME CONSUMING:** number of potential solutions cut down to expedite the analysis.
  - **LOW-COST ANALYSIS:** sometimes provided for free to open the conversations with the client and to gain his/her trust.
- Decision-making processed in engineering are unconsciously biased. [1]
- This dynamic leads to a **limited exploration of the potential solutions**.

[1] https://appel.nasa.gov/2018/04/11/mitigating-cognitive-bias-in-engineering-decision-making/

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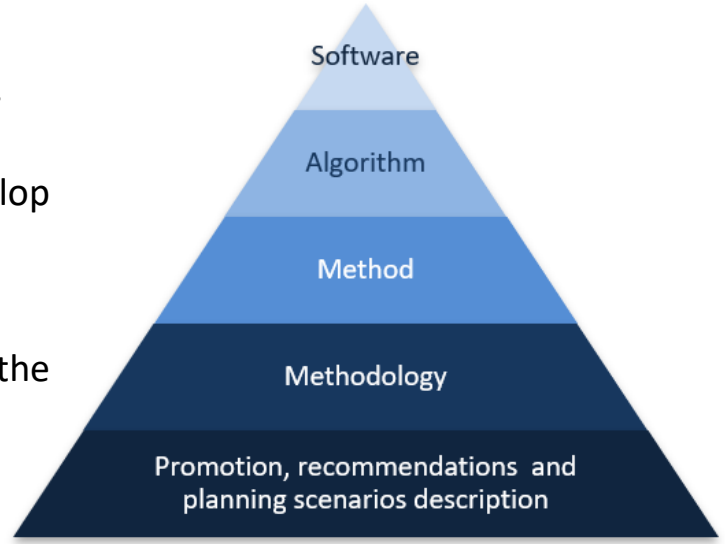
PROBLEM DEFINITION

- There is a **need for more advanced feasibility analysis tools and methods :**
  - Able to **expedite the study** of business opportunities in this market.
  - Able to **explore thousands of configurations** and scenarios in an agile and timely manner.
  - Able to **provide more detailed information on the economics**, allowing investors to develop a personal point of view prior to involving more technical entities in the process.
  - Able to **quantify the potential impact of uncertainties** on the long-term profitability of the project.
  - **Accessible both to engineers and users with limited or no engineering background.**
  - Leveraging **artificial intelligence to minimize biases and risks** of overlooking solutions that might improve the economics of the project.



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TOOL DESCRIPTION

GOALS OF THE TOOL

DEVELOPMENT OF AN AGILE FEASIBILITY ANALYSIS TOOL FOR NON-TECHNICAL USERS, PROVIDING ADVANCED FEATURES FOR TECHNICAL USERS TOO

To advance the state of the art of feasibility analysis methods for community microgrids and district energy by:

1. **Eliminating the cost barriers at the feasibility level,** increasing the interesting of investors on these systems.
2. **Reducing the engineering skills required by the users:** An investor with clear economic goals should be able to check if a district energy is a profitable solution without involving third companies.
3. **Integrating an innovative method** adapted to this planning problem **into a cloud-based tool**.
4. **Benchmarking the solutions found by the AI with those defined by a technical user,** identifying the obstacles to fulfill the goals of the project.

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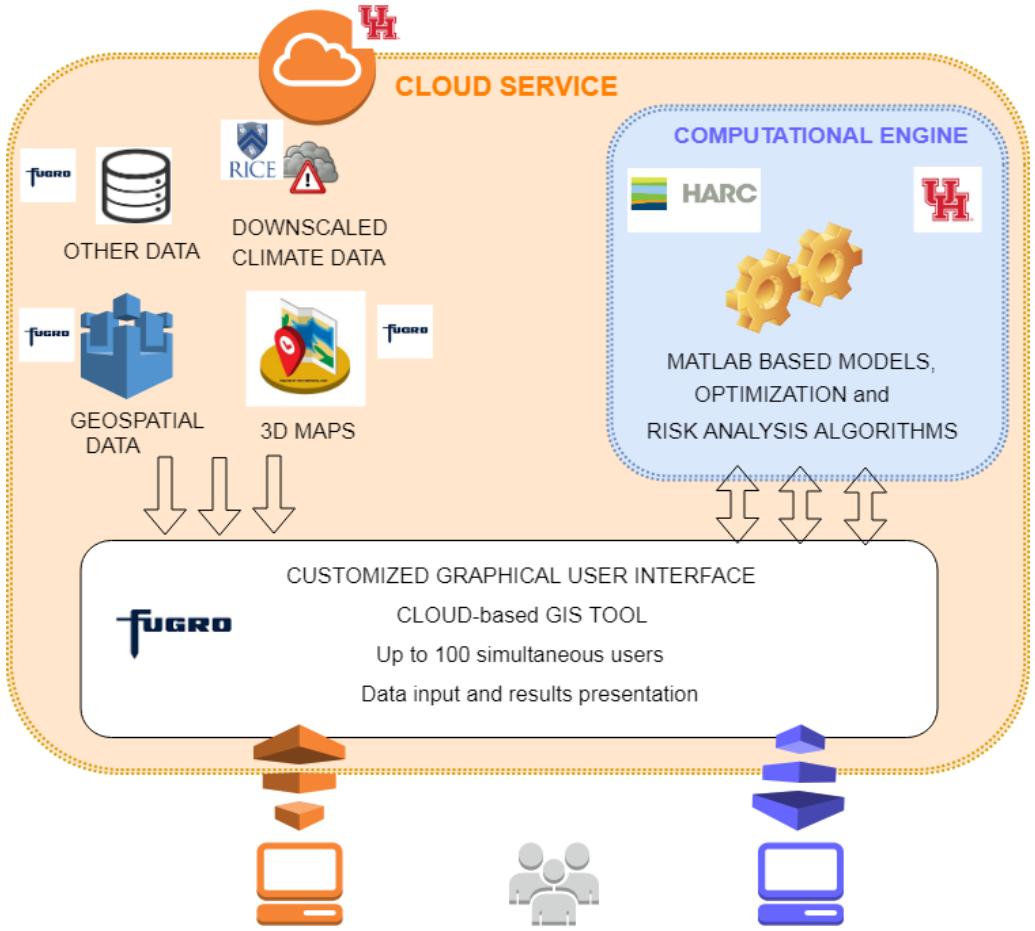
FEATURES OF THE TOOL

- **User-friendly tool** to expedite the feasibility analyses of District Energy Systems (DES) and multi-building microgrids.
- Digital twin with GIS capabilities → intuitive 3D environment for a detailed navigation and faster data input.
- Non-technical users can easily complete a feasibility analysis.
- Detailed description of the technical solution available for technical users.
- More accurate performance assessments based on future climate patterns downscaled from Global Climate Models.
- Defined probability for different economic results.
- Benchmark the optimal solutions proposed by the AI in the tool and by designers/engineers.
- **Online tool available at no cost.**

TOOL ARCHITECTURE

Integration of three Major Components: Graphical User Interface, Middleware and Computation Engine



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PROGRESS

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PROGRESS

Seven quarters into the project, the first part and version of the tool is being completed.

> TASK 1. Defining Users' Experience	
> TASK 2. Enabling the capabilities of the Tool	
> TASK 3. Iteration1: Data Input and Collection Through GIS	
> TASK 4. Iteration 2: Development of Computational Engine for DES Following the Power Demand	
> TASK 5. Iteration 3: Results Validation and Presentation Through GIS Tool 1	Nov 22
> TASK 6. Development of the Optimization and Risk Analysis components of the CE for DE	Feb 23
> TASK 7. Iteration 5: Results Validation and Presentation Through GIS Tool 2	May 23
> TASK 8. Guaranteeing user's experience: final tool validation	Aug 23
> TASK 9. User's Support materials Development. Public Release and Promotion of the Tool	Nov 23

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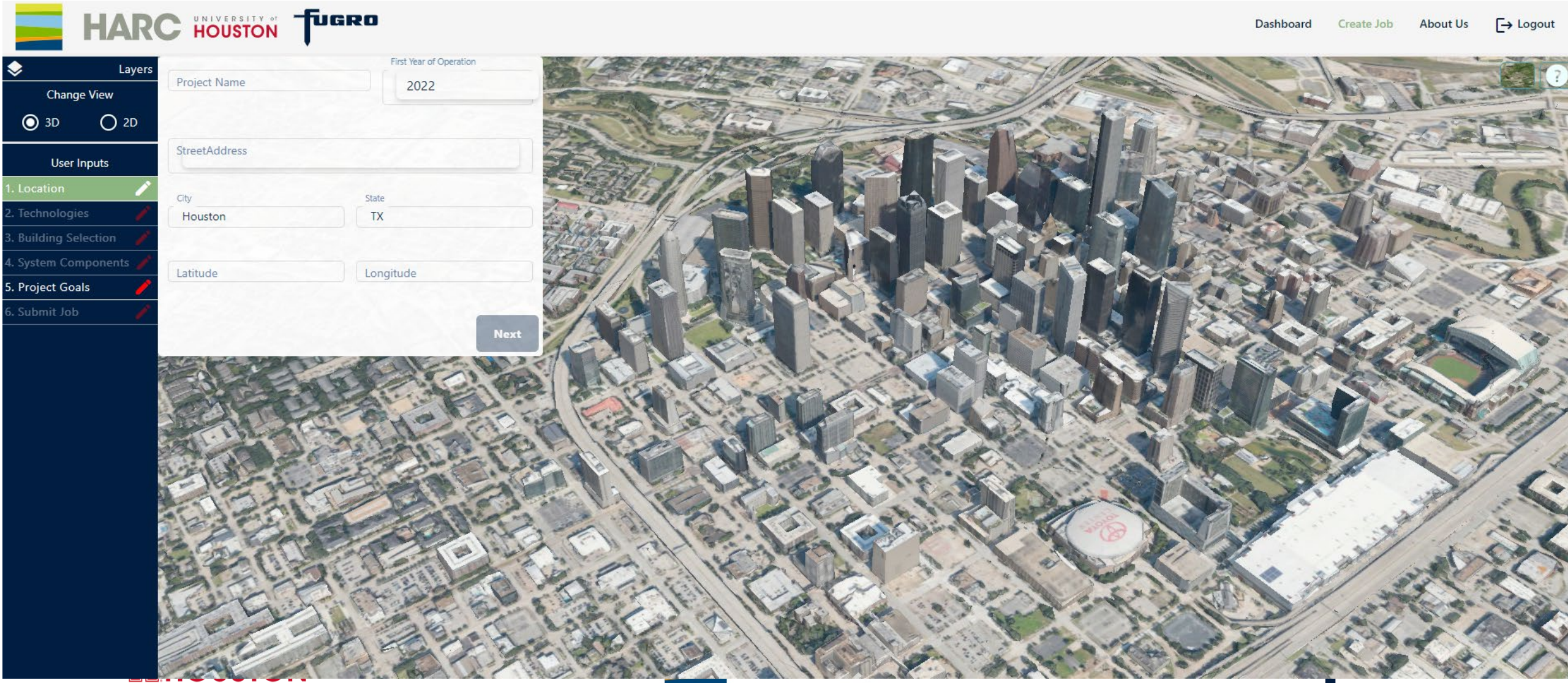
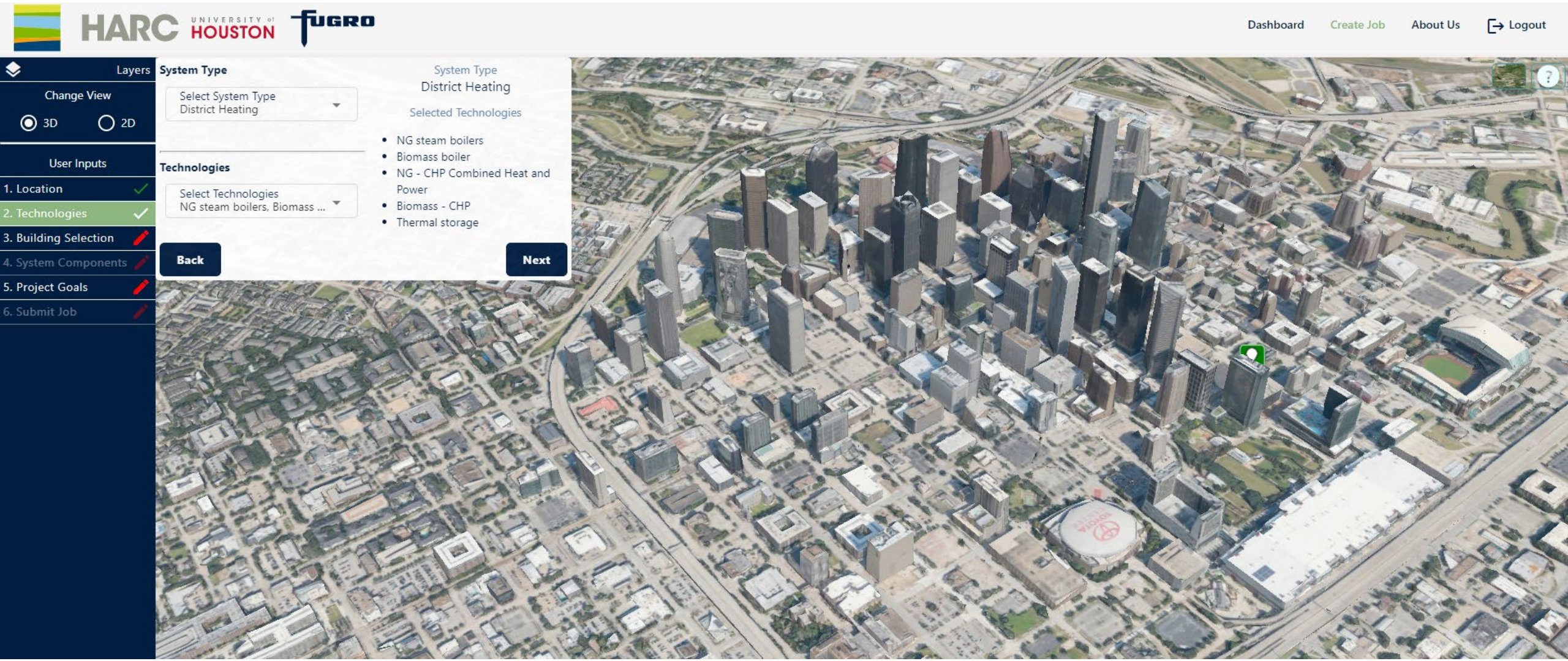
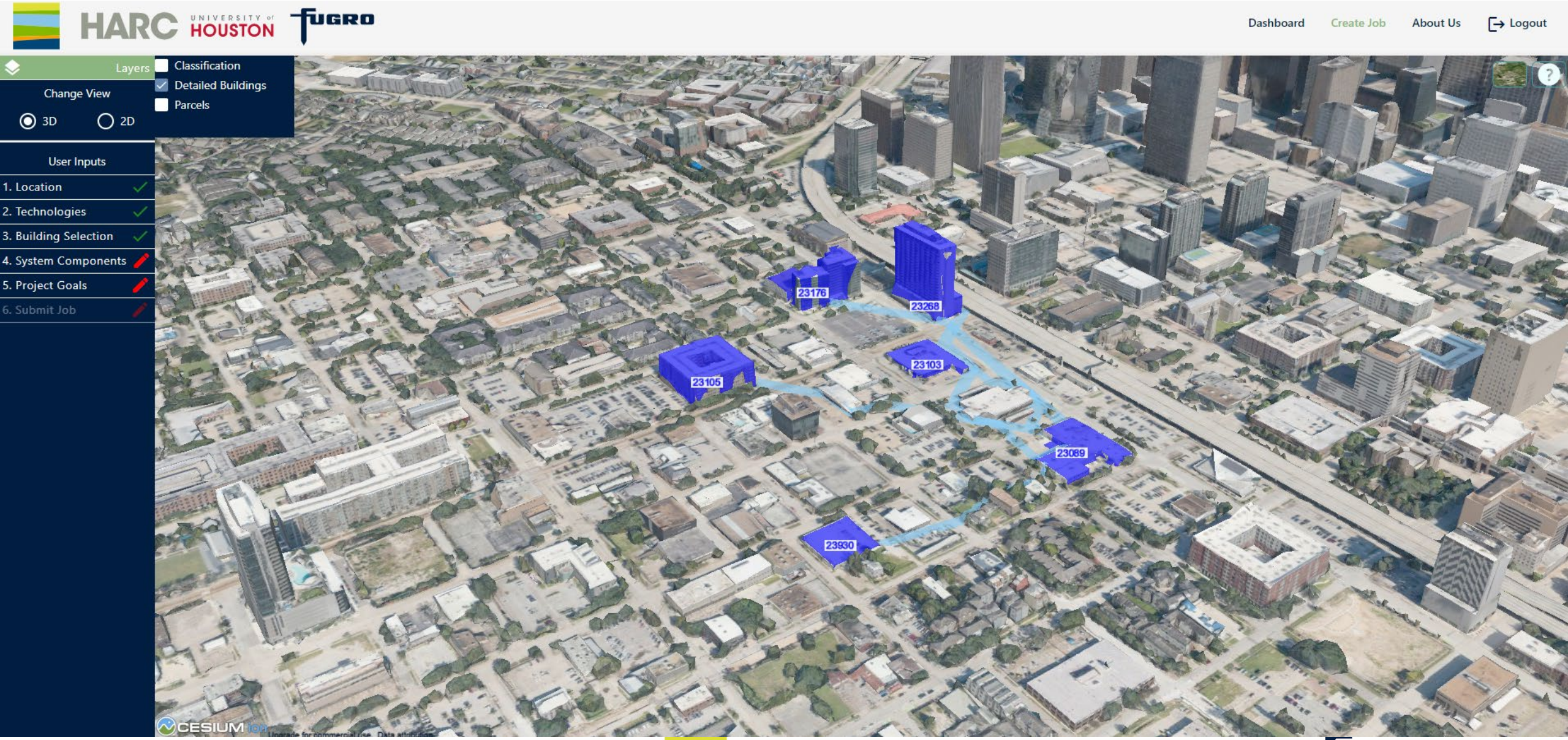
GRAPHICAL USER INTERFACE



GRAPHICAL USER INTERFACE

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3. Building Selection
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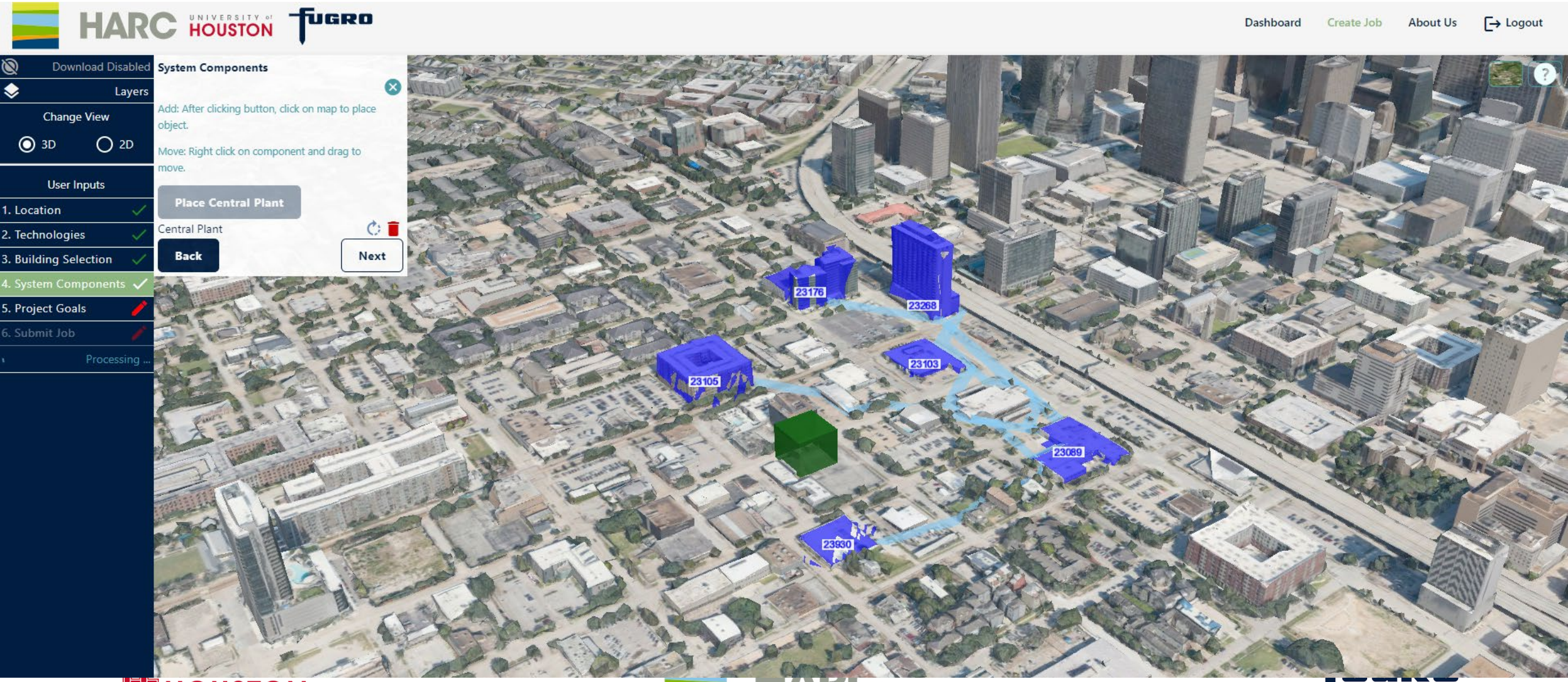
GRAPHICAL USER INTERFACE



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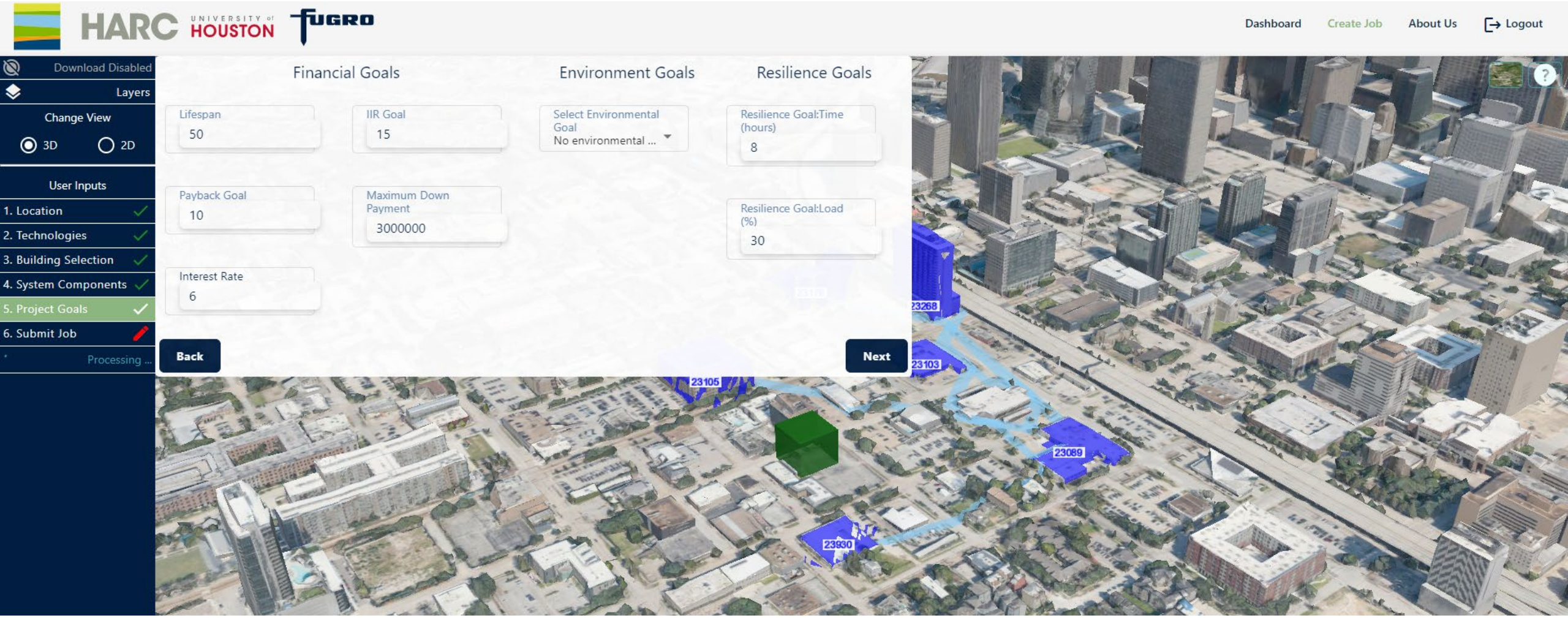

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NEXT STEPS

In the Next Six Months…

- Finalization of reporting capabilities and incorporating them into the GUI and Computations Engine
- Validation of the first version of the Computations Engine
- Testing of middleware
- Making the microgrid part of the tool available and intensive testing

Thank You!

Gavin Dillingham, Ph.D.

gdillingham@harcresearch.org

HARC

Carlos Gamarra, Ph.D., PE.

cgamarra@harcresearch.org

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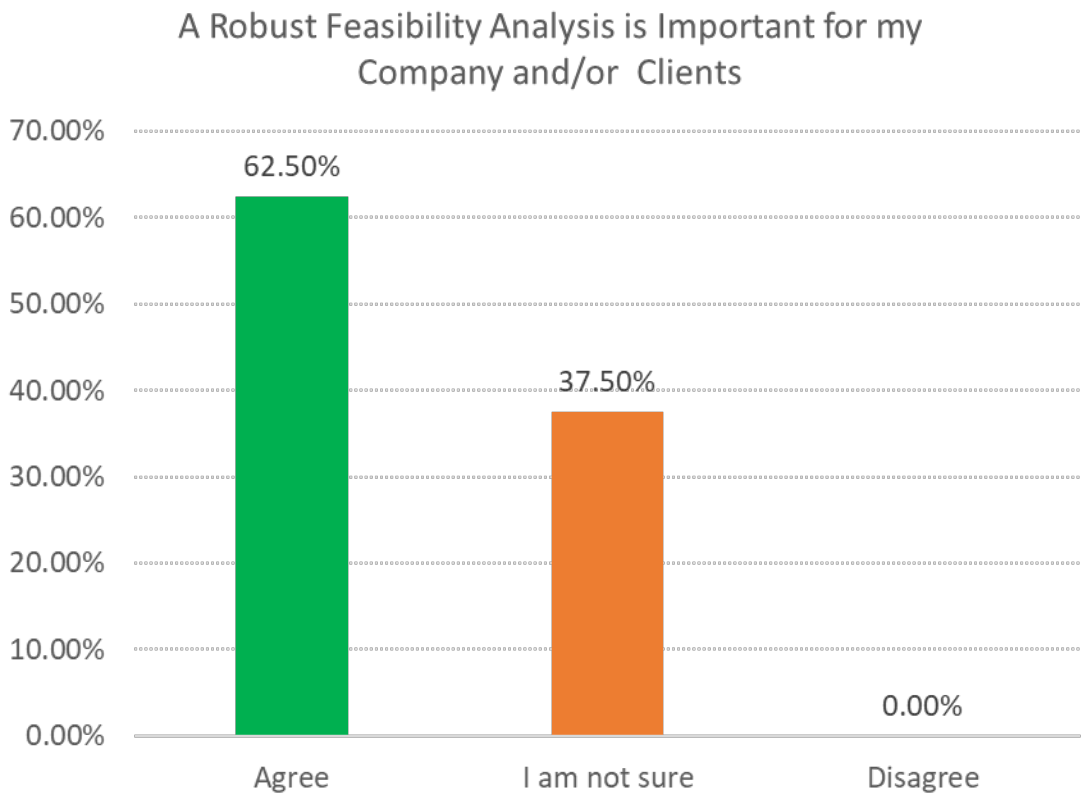
INITIAL SURVEY RESULTS

ONLINE POLL AND SURVEY RESULTS COMPARISON

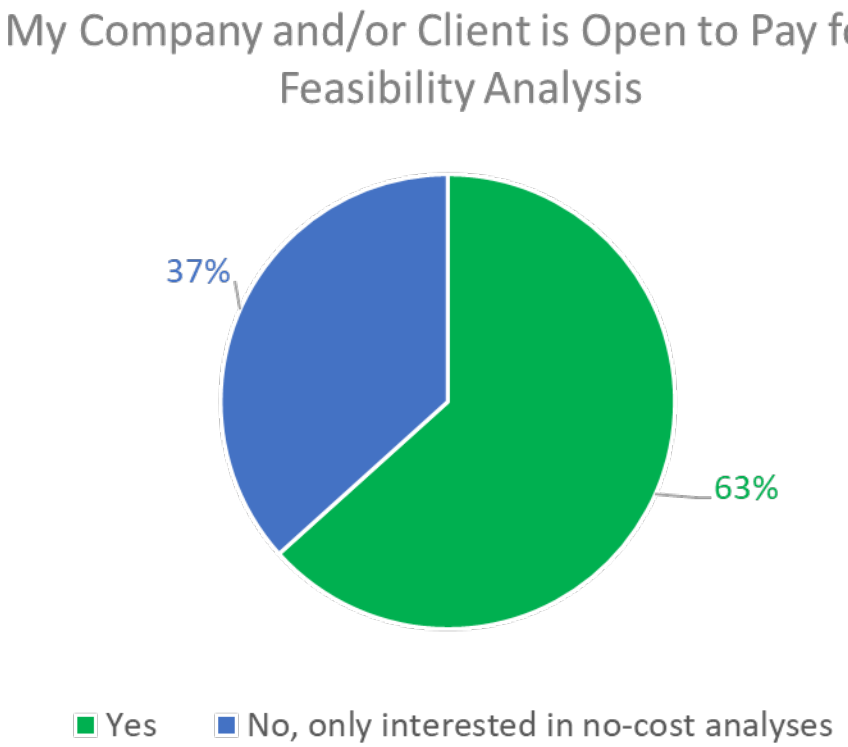
SURVEY RESULTS

- FAs are recognized as a relevant stage of the development a district energy or community microgrid.



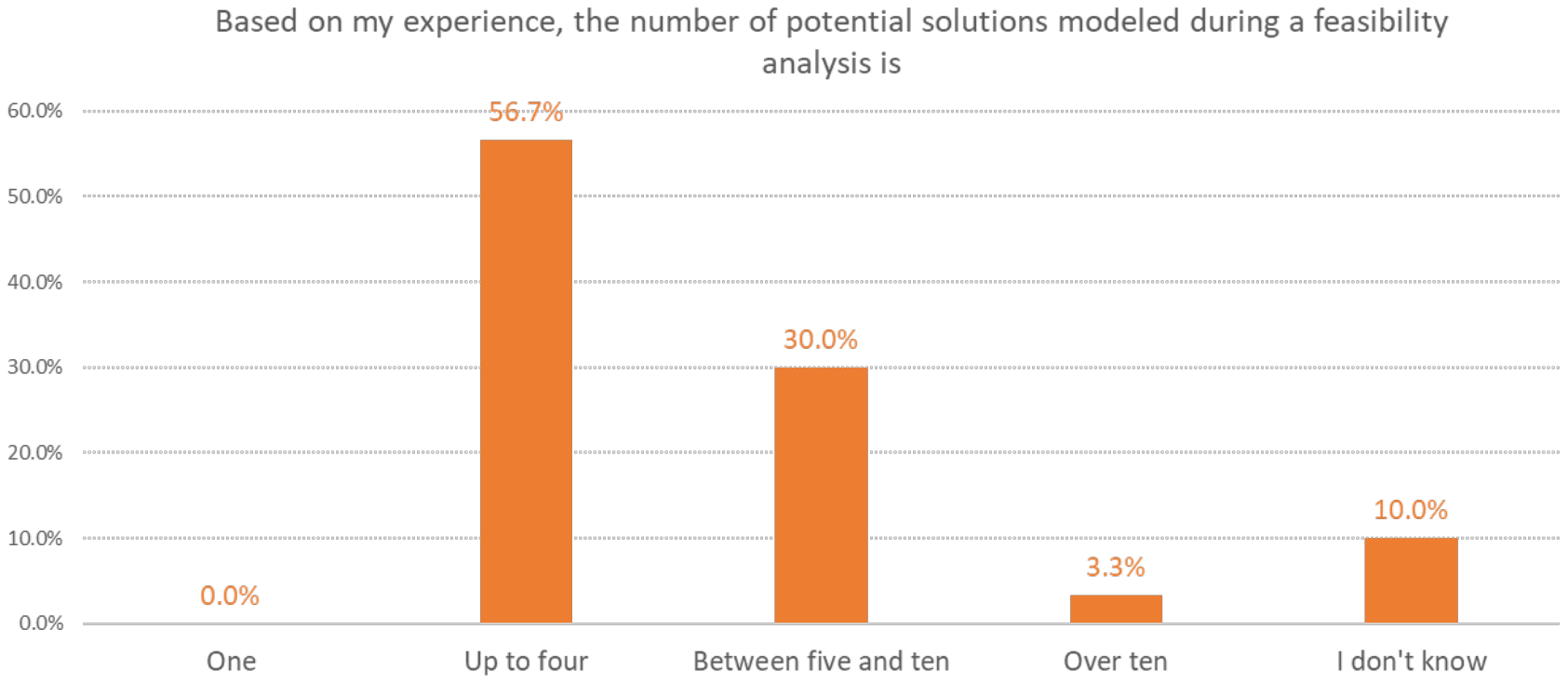
SURVEY RESULTS

- 63% of the respondents, or their clients, would be open to pay for a feasibility analysis of a district energy or a community microgrid



SURVEY RESULTS

- According to the respondents, over 56% of the feasibility analyses study up to four potential solutions



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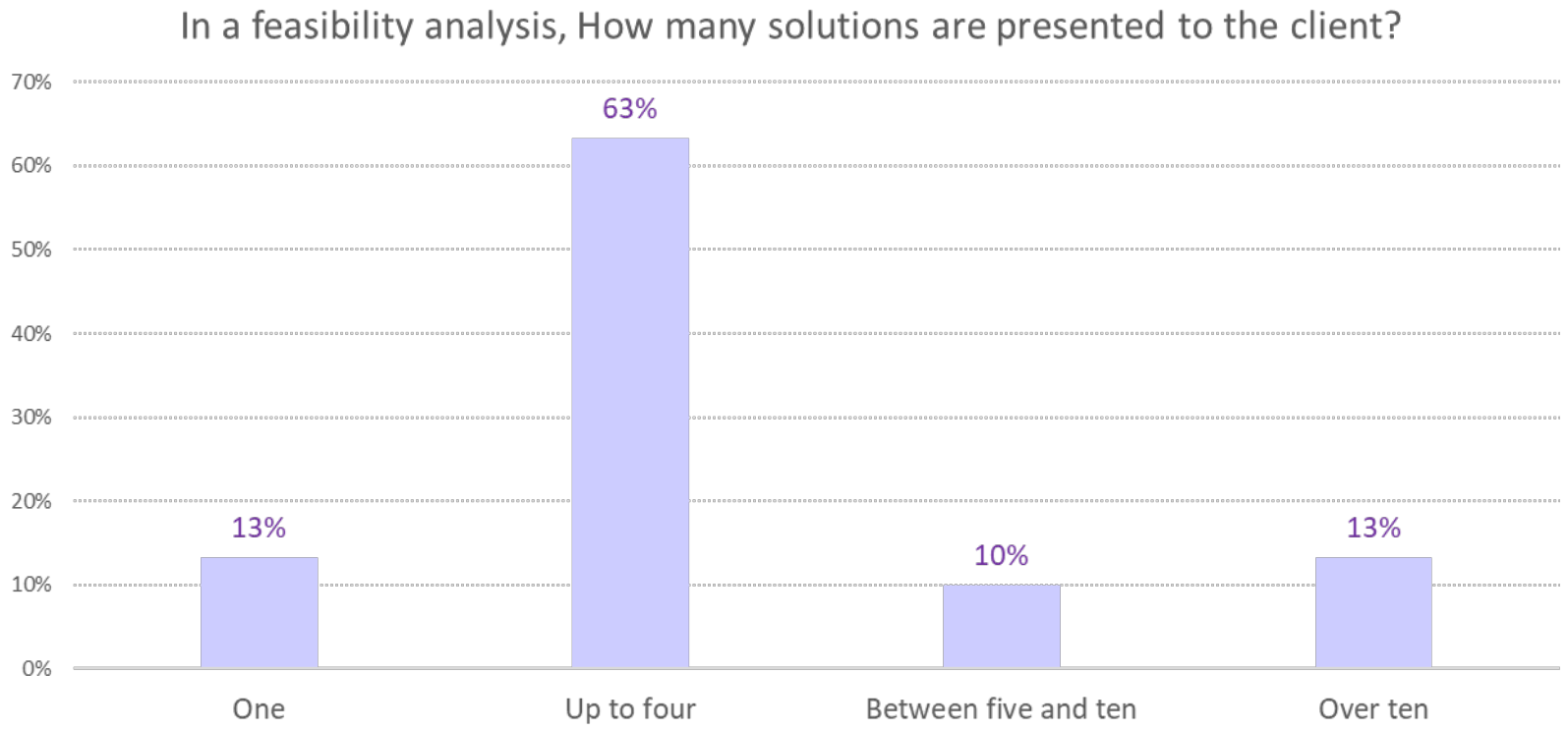
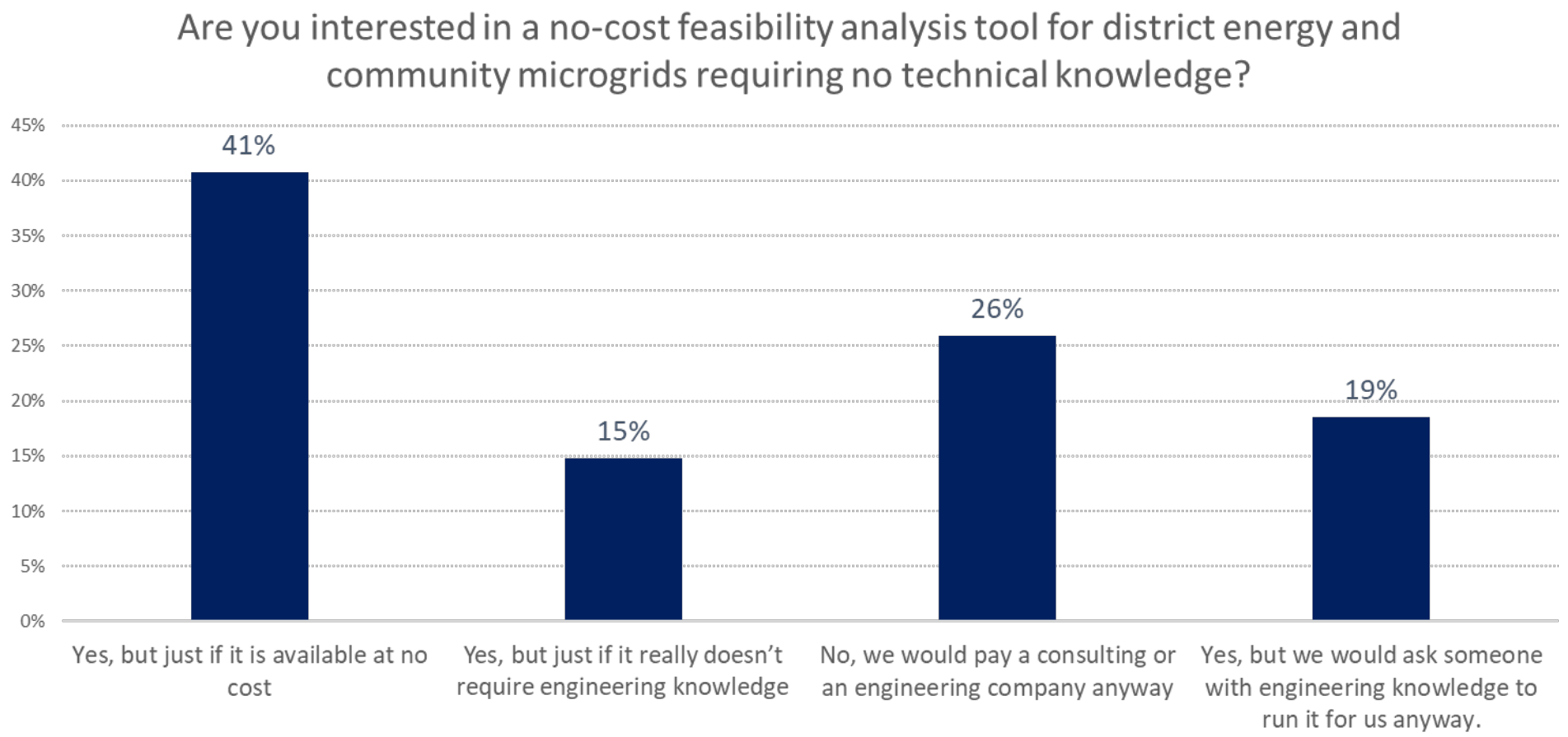
SURVEY RESULTS

- According to the respondents, up to four solutions are presented to the client as a result of a feasibility analysis.



SURVEY RESULTS

- According to the respondents, the cost factor is relevant to adopt the tool.



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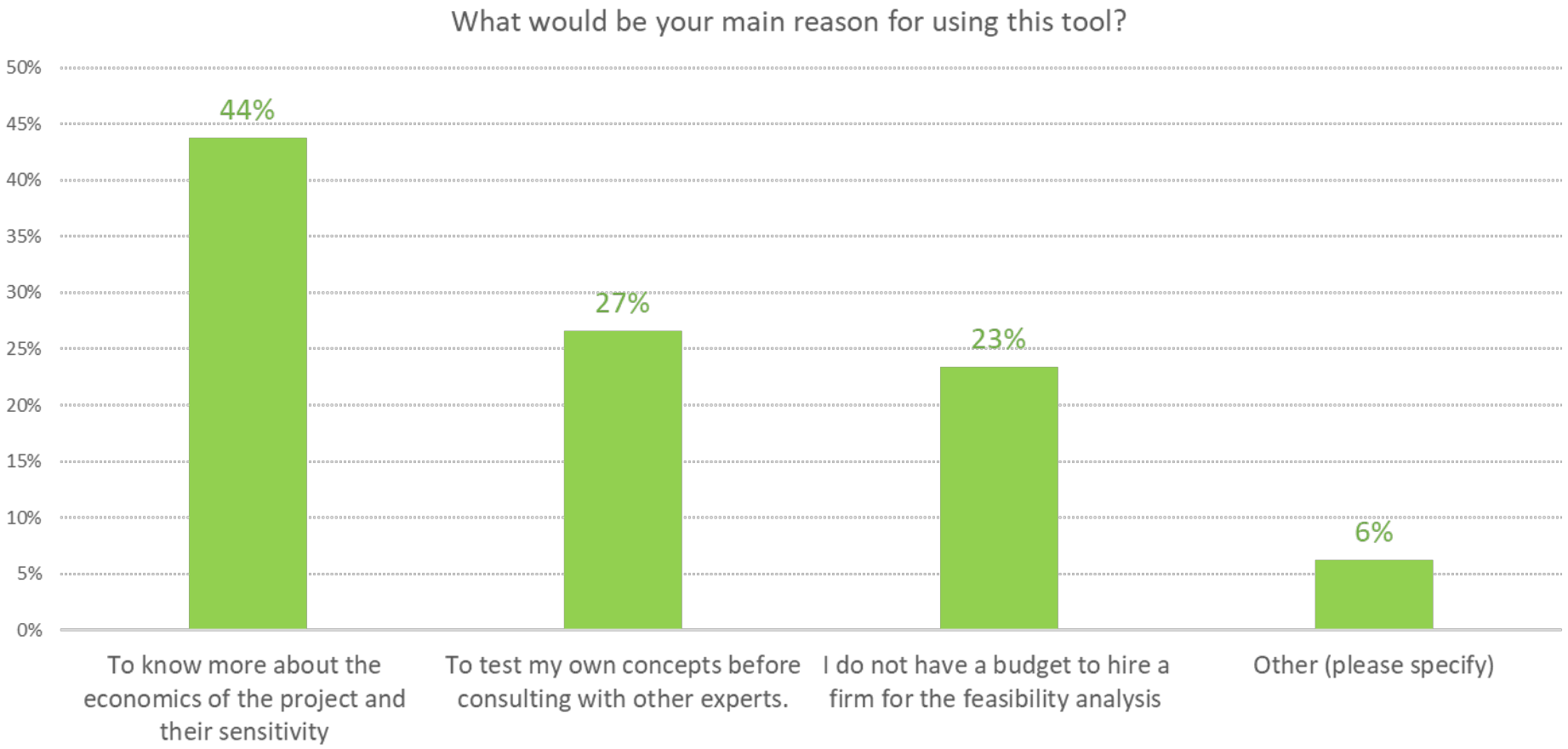
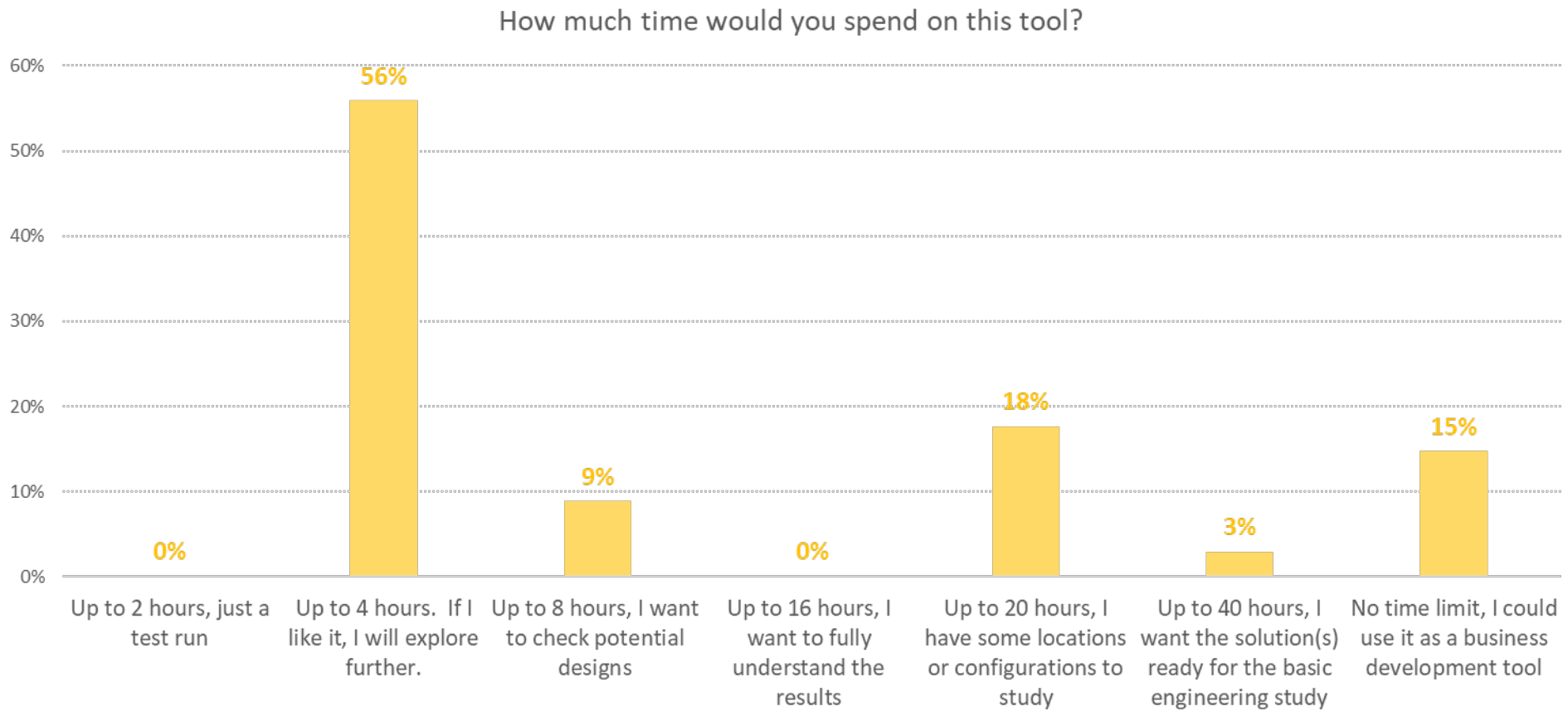
SURVEY RESULTS

- Respondents have shown interest in studying the economics and testing their own concepts



SURVEY RESULTS

- 56% of the respondents are interested on testing it while 44% are interested in using a tool like this.



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