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EnerGPT; A human-AI collaboration tool to envision energy future scenarios and stimulate debate

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Abstract

This paper investigates the potential of generative Artificial Intelligence (genAI) to support efforts toward energy justice and sustainability within the context of the Fifth Industrial Revolution (5IR), emphasising its role in facilitating inclusive energy transitions at the urban and community levels. Rooted in design research on digital for sustainability goals, our work focuses on the unique capabilities of genAI to make complex, often inaccessible data and processes more understandable and actionable for designers engaged in the energy transition. Recognising the socio-technical nature of energy justice, an intersectional approach is adopted to explore how genAI can help visualise and address disparities in energy access across different communities. We present EnerGPT, a custom GPT-based conversational agent trained on a corpus of datasets, policy documents, academic articles, and reports related to energy communities, energy transition, and social justice. The tool was developed to support designers in accessing and interpreting relevant information, formulating interventions, and imagining future energy scenarios that prioritise justice and inclusivity. Alongside the

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development of EnerGPT, a set of guiding prompts to help users navigate its capabilities and generate targeted outputs is produced. The paper reports on exploratory design sessions in which EnerGPT was used by interdisciplinary teams of designers tasked with developing place-based interventions to improve community participation in the energy transition. Our findings suggest that genAI tools like EnerGPT can enhance designers' ability to uncover hidden dimensions of energy poverty, compare energy access conditions between communities, and articulate more inclusive solutions. Beyond demonstrating the tool's practical applications, we critically examine the limitations and ethical implications of relying on AI to interpret and represent social justice issues. We argue that while genAI can augment human creativity and expand design capacities, responsible use requires new literacies and critical awareness. This work ultimately contributes to envisioning new pathways for design practice in the 5IR era that foreground equity, participation, and systemic change

Keywords: Energy Justice, Human-AI Collaboration, Custom GPT, Energy Transition, AI-powered Design

Introduction

In recent years, Artificial Intelligence (AI) technologies - particularly Generative AI (genAI) - have rapidly expanded their presence in our everyday lives. As genAI gets more integrated into our routines and work processes, research increasingly studies how this technology reshapes our professional environment (Dennehy et al., 2023) and collaborations (Hemmer et al., 2023; Wang et al., 2020). Among the variety of applications that genAI is finding in the professional world, its use in support of human decision-making processes is being increasingly investigated. GenAI is already transforming the way decisions are made, especially in low-risk scenarios, such as planning a tourist trip, medical image recognitions or supporting teaching frameworks (Albashrawi, 2025) GenAI allows for improving the efficiency and accuracy of decision-making, especially if combined with human reasoning (Lopez-Solis et al., 2025). It also holds potential for improving access to large data (Cano-Marin, 2024), enabling new forms of knowledge analysis and visualisation, like enhanced imaging and schematic synthesis (Ye et al., 2024), that support inclusive design practices by making knowledge more accessible and graspable, and which can ultimately contribute to shaping just and equitable transitions, especially in public environments. Despite growing interest, it remains underexplored how genAI contributes to complex decision-making, such as policy making, urban planning and other contexts where multiple stakeholders must make decisions with long-term social, environmental and economic impact.

This paper aims to fill this gap and sets out to understand whether genAI tools can truly and effectively support designers, engineers and decision-makers in exploring complex socio-technical futures (RQ1), and whether and how they bring unique values to decision-making processes (RQ2).

We developed EnerGPT, a custom GPT-based conversational agent trained with a selection of datasets, regulatory documents and reports focusing on social justice, energy transition, energy communities and local policies from the city of Turin, Italy. Alongside the tool, we defined a set of instructions to help users navigate the conversational space, including example prompts and expected outputs to support specific moments of the design process. The tool was tested in exploratory sessions with designers and engineers who were tasked to envision an energy future and a strategy to achieve or prevent such future.

Analysing the session and collecting feedback from participants, we provide insights about how genAI fosters accessible, multi-stakeholder dialogue around complex socio-technical futures, and encourages divergent thinking, but how it comes with practical challenges and concerns that designers and decision-makers need to account for. The paper ultimately contributes with practical recommendations for leveraging genAI in decision-making processes, and for effecting human-AI collaboration more broadly.

Human-AI Collaboration in Design

As it often happens with novel technologies, until recent years, AI research has predominantly focused on technical developments and exploration of new applications enabled by these. In fact, it has become evident that such approaches may fall short in understanding and anticipating societal, individual and environmental impacts – even harms (Bender et al., 2021; Weidinger et al., 2022)– that these technologies carry. Out of these widespread concerns, there has been a call to work towards Human-Centred AI (HCAI) (Shneiderman, 2022; Capel and Brereton, 2023): an approach that prioritizes meaningful human control, centers people by serving human values such as rights, justice, and dignity, and ultimately aims at achieving goals like self-efficacy, creativity, responsibility, and social connections (Shneiderman, 2021).

Within HCAI studies, a large body of research is dedicated to understanding emerging human-AI relationships, especially in collaborative contexts. By working together, AI systems and people can achieve better results and increase their capabilities compared to working autonomously (Capel and Brereton, 2023). This paradigm is showing promises in many fields, such as data science (Wang et al., 2019), healthcare (Zhang et al., 2024), qualitative research and data analysis (Feuston and Brubaker, 2021), music composition (Louie et al., 2020; Tron Gianet, Di Caro and Rapp, 2025), design ideation (Chiou et al., 2023), and everyday creativity tasks for both individuals and teams (He et al., 2024; Muller, He and Weisz, 2024).

However, human-AI collaboration also requires careful considerations for how AI systems are integrated "into the already-complicated human workflow" (Wang et al., 2020), where most activities are already done collaboratively. Further, collaboration is often thought of as limited to a one-to-one interaction. This fails to capture the complexity of real-world interactions as, in practice, collaboration often involves multiple human agents and is contextual. Cabitza, Campagner and Simone (2021) warn against this dominant AI approach, as it does not adequately account for the contextual, collaborative, and relational nature of decision-making. It is then crucial to address human-AI collaboration as a situated, contextual and multi-stakeholder interaction. In collaborative contexts, AI can take on new roles beyond just idea generation, such as facilitating group processes, moderating discussions, and guiding consensus-building (Shin et al., 2023). However, AI's roles and values in collaborative decision-making processes remain unexplored.

AI in decision making and in strategic foresight processes

Full AI's ability to analyse vast amounts of data can help experts make more informed choices to navigate uncertainty, assess risks, and develop more data-driven strategies to achieve just and correct decisions. This is already happening in a variety of low-risk decision-making contexts, such as healthcare for medical image recognition, and customer service to help clients in solving issues (Muhammad, Sagatovna, 2024).

GenAI is increasingly being explored for more complex foresight applications, particularly in policy-making domains like finance, where it is used to analyze trends and make proper decisions (Muhammad, Sagatovna, 2024), and in particular on sustainable decision making where it is used for its potential to spot inefficiencies, reduce wastes and optimizing resources management (Khalid et al., 2024). Policy making around climate change and energy transition is an area where decision-makers heavily rely on models to predict possible futures, uncertainties to shape long-term strategies (Pérez-

Ortiz, 2024). In such contexts, foresight – especially responsible foresight– can be crucial. Strategic Foresight identifies drivers of change and defines adaptive strategies and responsible foresight actively explores likely, unintended, and desirable futures to guide equitable decisions(Brandtner, Mates, 2021, Pérez-Ortiz, 2024). GenAI can enhance strategic foresight in policymaking by rapidly processing diverse forms of knowledge, identifying patterns, and generating timely insights to support informed decision-making.

It allows for easy access to information, makes processes more interactive and adaptable to the visions and skills of diverse stakeholders.

Nevertheless, the potential of genAI to make foresight processes more accessible and interactive for non-expert users, such as community members or local decision-makers (as encouraged by institutional initiatives worldwide, and especially in the European Union (EU, 2023), and to support a more inclusive and just transition remains underinvestigated.

Methodology

This study investigates how generative AI tools can support foresight activities used in decision-making processes within the context of energy, climate, and social transitions. We develop EnerGPT – a custom chatbot based on GPT-4o – designed to act as a facilitator in decision-making foresight workshops around energy-related issues, involving a multidisciplinary group of participants. We evaluate the tool's potential to stimulate debate, accelerate participatory foresight processes, enhance the exploration of plausible scenarios, and support strategic thinking through AI-guided foresight exercises

EnerGPT embedded knowledge

EnerGPT was trained and knowledge was uploaded by using the default feature from OpenAI, which allows the use of natural language, instead of coding, to instruct and iteratively improve its behaviour. The repository consists of 20 documents, such as scientific articles, open datasets and public reports, from the city of Turin, Italy. Moreover, this knowledge is permanently embedded, helping us to keep methodological consistency and data traceability. The repository consists of three thematic clusters:

- Foresight Methodologies. Five documents describing futures thinking techniques used in the workshop, (i.e. Futures Wheel, 2x2 Scenario Matrix, Causal Layered Analysis, Force Field Analysis, Pre-Mortem Analysis)
- Policy and Socio-Economic Context. Eleven documents encompassing climate policy, regional energy data, socio-economic conditions, and case studies on energy justice, with a geographical focus on Turin and the Piedmont region.
- Quantitative Regional Datasets. Three CSV datasets provide quantitative knowledge in energy consumption, building energy performance, and electrification trends.

Bringing these documents (full documentation available at link) into the permanent knowledge base of the CustomGPT allowed us to enlarge the understanding of the GPT about our case study. Giving it reports about Energy policy gave the possibility to leverage realistic and feasible strategies and actions from the energy field to think with. Other documents, such as the climate resilience report or the last urban development policy, were chosen to ensure a more systemic and intersectional analysis of the theme selected to explore the future.

A multidisciplinary workshop with EnerGPT

To evaluate EnerGPT's usability and potential to support decision-making processes, we organized a one-hour in-person workshop with eight participants: four energy engineering PhD students, one engineering student, and three design researchers, all with interests and experience related to renewable energy, energy communities and sustainable city-making. The session was structured into three main phases. In the introduction, the authors presented the purpose of the activity, explaining EnerGPT's key functionalities and expected outputs through an example.

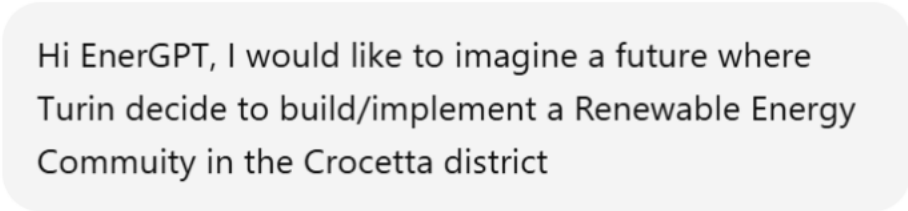


Figure 1: Starting prompt for EnerGPT

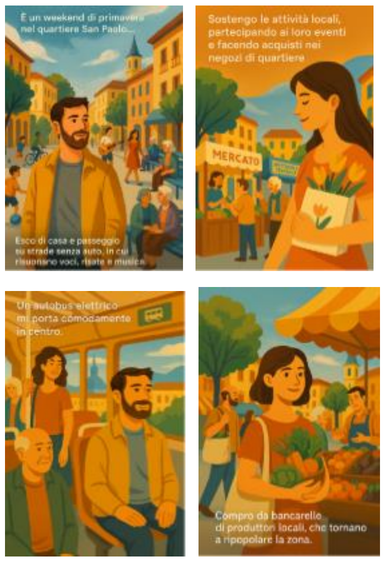
During the central phase, participants worked individually with EnerGPT. Each was provided with a document containing the workshop instructions, a link to EnerGPT, and an initial prompt structure to customize. Participants selected one available foresight method and interacted autonomously with the chatbot to develop a future scenario based on their interests or research. Each participant generated a first-person narrative describing a future situation and created four visual milestone cards representing key events leading up to that future. Lastly, each participant was invited to synthesise their scenario by completing a final template statement: "In 2035, in [selected neighbourhood], there will be [future situation]. To get there, the following actions were taken: [Action/Decision 1], [Action/Decision 2] ...". This template aimed to provide closure to the activity, facilitate comparison among participants, and stimulate reflections on non-direct implications. In the final phase, some participants shared their scenarios and milestone cards with the group. The debate focused on comparing the generated futures, discussing their plausibility, and strategic relevance. Discussion focused on how EnerGPT influenced participants' reasoning, revealing its opportunities and limitations of the tool. To gather structured feedback, we collected data through an adapted version of the User Experience Questionnaire (UEQ, 2024) completed by all participants and conducted semi-structured interviews with three of them. Each participant submitted their chat transcript, final scenario narrative, and milestone cards, compiled into a workshop document. This material showed how EnerGPT's responses varied with participants' interaction styles, providing usability insights and qualitative evidence on how researchers engage with AI-generated futures in complex socio-technical contexts like urban energy justice.

Results

Here we report the main findings from the exploratory workshop, organised into three areas: 1) insights into participants' interaction with EnerGPT (based on chat analysis and observations), 2) generated scenarios, and 3) user experience evaluation (based on questionnaire results and post-workshop interviews).

EnerGPT embedded knowledge

Each participant interacted with EnerGPT for approximately 40 minutes. The interaction followed the guided structure described in Section 3. This structure asks participants to define the topic they wanted to explore and to localise it within a specific neighbourhood of Turin Italy. After submitting the initial input, participants selected one foresight method and – interacting with the chatbot – generated three types of outputs: a first-person narrative scenario set in 2035, four visual milestone cards and a final statement that consist in a list of actions to reach the envisioned future. Table 1 provides a brief overview of participants, chosen method, location and final cards.

<table>
<tr><th>Participant</th><th>Method</th><th>Place explored</th><th>Theme Explored</th><th>Cards</th></tr>
<tr><td>1</td><td>Future Wheel</td><td>San Donato</td><td>Urban agriculture and photovoltaics by installing raised greenhouses with solar panels.</td><td>
</td></tr>
<tr><td>2</td><td>Pre Mortem</td><td>San Paolo</td><td>Closure to private traffic on weekends and holidays in the Turin district of San Paolo</td><td>
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3	Causal Layered Analysis	Mirafiori	Usage of sustainable road paving in Mirafiori, in the Industrial area	
4	2x2 matrix	Turin	sustainable mobility in Turin with a mix of electric, hydrogen and biomethane vehicles	
5	Causal Layered Analysis	Santa Rita	New zero-impact elevated metro line in Santa Rita district, powered by photovoltaic panels	

<table>
<tr><td></td><td></td><td></td><td></td><td>
</td></tr>
<tr><td>6</td><td>Forced Field Analysis</td><td>Crocetta</td><td>Renewable Energy Community in the Crocetta district of city center</td><td>
</td></tr>
<tr><td>7</td><td>Forced Field Analysis</td><td>Center</td><td>a Positive Energy District (PED) in the center area</td><td>
</td></tr>
<tr><td>8</td><td>Pre mortem</td><td>Turin</td><td>Centre of Turin, al houses, have photovoltaic on their roof</td><td>
</td></tr>
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Table 1: Overview of used methods, place explored and generated cards

Participants received minimal support. In a few cases, minimal technical issues occurred (e.g., freezing), but were easily resolved by refreshing the page – no data was lost and the chat history remained available. Observation of the chats and participant behaviors during the workshop revealed how different styles of interaction influence the final output. Those who engaged more in the conversations – adding contextual details or explicitly asking for more elaboration (e.g., *"elaborate a longer narrative"*, P2) – tended to obtain richer, more complex scenarios. For example, P1 opened with the following prompt:

> *"Hi EnerGPT. I would like to imagine a future where, in Turin, we decide to combine urban agriculture and photovoltaics by installing greenhouses made with solar panels in San Donato neighborhood."*

This input led to a multi-faceted scenario, with implications not only for energy but also for biodiversity, education, and urban regeneration.

By contrast, more generic prompts – such as the one submitted by P6 -

> *"Hi EnerGPT. I would like to imagine a future where, in Turin, we decide to create a Renewable Energy Community in Crocetta neighborhood."*

resulted in less detailed and less contextualized narratives. Selected foresight method also influenced the nature of the interaction. Participants using *Causal Layered Analysis* tended to write longer, more reflective prompts from the outset. For instance, P3 shared the following statement:

> *"I would perhaps add that there are the following archetypes in this discourse: new technologies are uncertain, and then asphalt we have always used it why should we change it"*

This type of input enabled EnerGPT to produce more layered outputs. In contrast, participants using, for instance, *Force Field Analysis* were generally more guided by the tool itself. This method's structure – focused on identifying enabling and resisting forces – allowed the chatbot to take a more active role in shaping the scenario for the participants. In these cases, participants tended to confirm or adjust suggestions, engaging less in open narrative construction.

Generated Scenarios

Participants developed a total of eight possible futures, produced through the interaction with EnerGPT. Each consisted of a first-person narrative, four milestone visual cards illustrating key moments or key features of that future and a final action statement outlining practical decisions one could take to realise that scenario. This statement aims to simulate an actual decision-making process and functions as a roadmap.

Generated scenarios present recurring patterns, for instance, most narratives were optimistic and enhanced both technological solutions and social aspects. Participants explored zero-emission transport, energy communities, urban agriculture, and district photovoltaic coverage. Other topics like cultural or behavioural aspects were introduced by the chatbot during the conversation or in the final narrations. P8 never talked about social topics themselves but those were introduced by EnerGPT during the development of the method and took place in the final narrative (i.e. "A group of citizens started organising public meetings[..]" (P6). This underlines EnerGPT's capacity to bring different issues into discussion and help stakeholders to have a more holistic view of possible consequences.

Visual outputs did not meet expectations. Contrary to our hypothesis, the milestone cards were often unclear and did not effectively support reflection and were often criticized by participants, shifting focus from scenario content to their limited usefulness

Lastly, each session concluded with a short prompt inviting EnerGTP to outline actions taken to reach the envisioned future. These ranged from policy interventions and pilot projects to community initiatives or huge technological implementations. Those lists of actions varied significantly in the number of options and level of detail. Some participants received comprehensive lists with six or more articulated steps, while others obtained only one or two generic suggestions. In general, several actions appeared structured and plausible such as "Adoption of a new Turin's 2030 Climate Plan that included the gradual replacement of asphalt with sustainable materials in the suburbs." (P3) others were overly vague (e.g., "Installation of the first photovoltaic systems on public buildings such as schools [...]" (P2)) or based on inaccurate assumptions about the local context (e.g. "Redevelopment of an existing elevated road lane to minimize soil impact and accelerate construction."). The level of detail in those final statements shows that these sentences can be used as a cue for starting a conversation, but they do not necessarily support the development of the idea. One interesting pattern with the Pre-Mortem method, participants didn't receive actionable plans but lists of failure causes (i.e. Poor initial maintenance of infrastructure, which increased breakdowns [...]" (P7)) serving more as "what to avoid" than as steps toward a desirable future.

Generated Scenarios

User experience evaluation was conducted by collecting feedback through an adapted version of the UEQ-S questionnaire, where participants rated their EnerGPT experience on a 1–7 Likert scale. Patterns showed in Table 2 suggest that EnerGPT's contribution is perceived as more valuable in ideas exploration rather than being supporting in practical tasks.

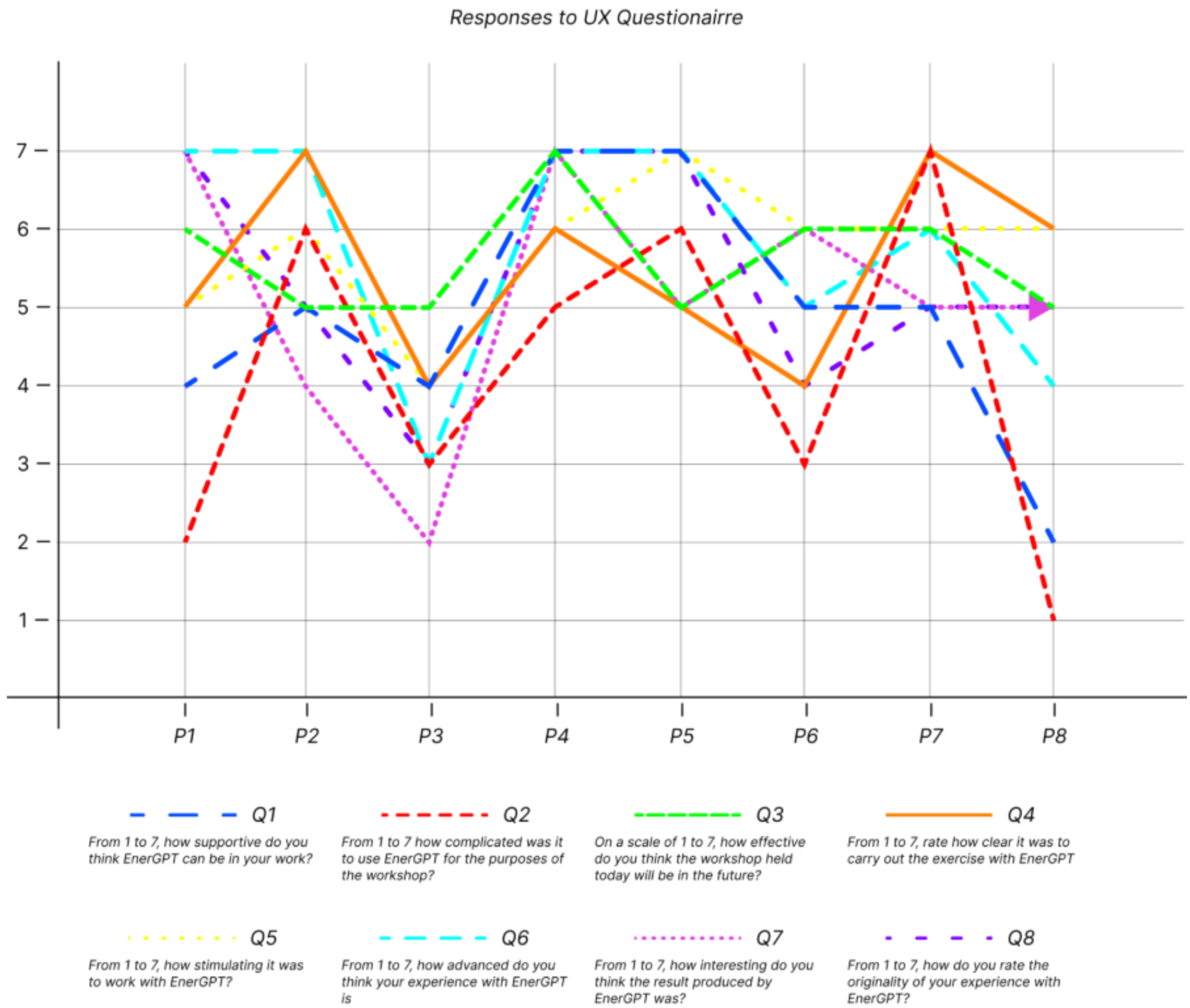

Figure 2: UEQ-S item-level scores (1–7) for EnerGPT during the foresight workshop; higher values indicate better experience on each item. These scores inform the two macro-dimensions summarized in Table 3

Results were analyzed following the UEQ-S data analysis (2024). Overall users' experience was positive (1.297) (Figure 3). Figure 3 aggregates the item-level UEQ-S scores reported in figure 2 into the two macro-dimensions, Pragmatic Quality and Hedonic Quality, to provide a condensed view of where EnerGPT is perceived to add value. In our data, Hedonic Quality is higher than Pragmatic Quality, indicating that participants experienced EnerGPT more useful in supporting concepts exploration, brainstorming more than late-stage execution. The Pragmatic Quality scale showed a weighted mean of 1.08, indicating acceptable clarity in doing the workshop (m=1.6) and supportive for their work (m=0.9). The Hedonic Quality scale scored higher, with a weighted mean of 1.55, suggesting participants found the experience original (1.5) and stimulating (1.1).

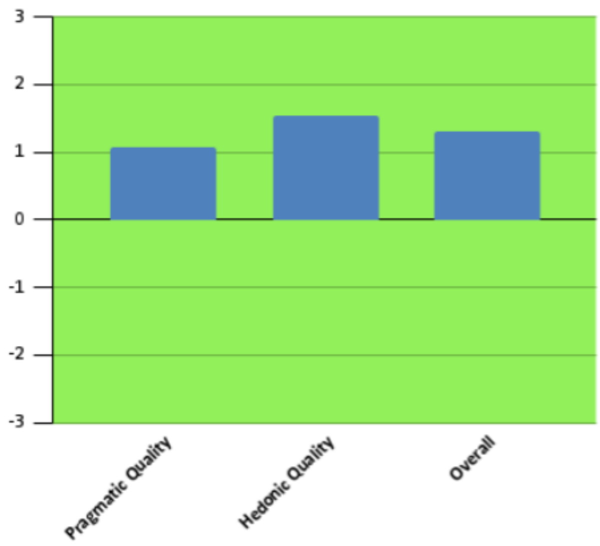

Figure 3: UEQ-S macro-dimensions. Hedonic Quality (weighted mean 1.55) > Pragmatic Quality (1.08), indicating EnerGPT's stronger contribution to originality and stimulation vs. task clarity and efficiency in this setup

In addition, follow-up interviews conducted days after the workshop revealed how participants perceived EnerGPT. P3 found EnerGPT helpful for organizing ideas and later reused parts of the chat to present his project more clearly. P8 considered it not useful at his current stage but saw its potential as a support tool during brainstorming. P6 was more critical of the final outputs, stating that the narrative was "banal and vague". However, he also declared that one suggestion – regarding energy in residential buildings – sparked further interest and nudged them to investigate the topic more deeply. Both P6 and P8 considered EnerGPT particularly useful during early-stage ideation, helping to identify key actors and reflect on possible consequences. P6 further suggested that adding precise, place-based data – such as the presence of asbestos rooftops – could enhance its value for cost analysis and scheduling These qualitative insights, reinforced by the item-level patterns in Table 2, suggest that EnerGPT functions not only as a foresight and speculation tool but also as a stimulating thinking partner—supporting users in organizing and communicating ideas in structured and compelling ways, while offering uneven procedural support. Interviews illustrate this dual role: P3 leveraged the tool to organize and present ideas, P8 valued it for early-stage brainstorming, and P6, while critiquing the narratives as too generic, still acknowledged that even a single suggestion triggered deeper inquiry.

Discussion

The findings underline the ability of EnerGPT to support future-oriented idea generation, useful in the early stages of projects, where exploration and divergent thinking are crucial. While the exploratory nature of our workshop does not allow for statistical generalisation, the insights collected provide indications on how such tools could function when integrated into real-world decision-making contexts involving designers, engineers, policymakers, and citizens.

EnerGPT experience

Our observations reveal that a proactive and dialogic interaction with EnerGPT — where participants actively contribute contextual information, request clarifications, and refine chatbot suggestions — tends to result in richer, more plausible, and more situated outputs. Those who approached the tool as a collaborative partner rather than as a passive content provider obtained higher-quality scenarios. This dynamic was noticeable among participants at the beginning of their PhD programmes, suggesting potential benefits of such tools during early project phases, when topics and approaches are still being defined. Moreover, participants were encouraged to bring personal research interests and local knowledge into the conversation, which further influenced the depth and relevance of the outcomes. Extending this model to multi-actor scenarios — such as co-design sessions with policymakers or community representatives — that may allow comparing and aligning perspectives to foster richer dialogue around a shared theme.

Possible real-world application

Although our workshop involved a convenience sample of participants, the outcomes still highlight potential roles that EnerGPT and genAI tools more broadly could play in more complex and structured participatory decision-making contexts. We show that genAI systems can act as *thinking partners* for generating both expected and unexpected visions of the future, helping participants to develop a broader and more holistic understanding of the context under discussion. But while the notion of AI and thinking partner is acknowledged in the design and HCI fields (Simeone, Mantelli and Adamo, 2022; Karimi et al., 2020), the further value of genAI we identify is less so. genAI also functions as a *tool for externalising and structuring ideas into dialogic artefacts,* such as narratives and visual milestone cards, that facilitate comparison and synthesis of different contributions. This way, genAI tools have the potential to also support more democratic dialogue around topics of public interest, by providing a neutral interface that renders individual contributions into a common language, both textual and visual. This could help ensure equal style and legibility in the contributions from diverse participants, with varying capacity to express through language and sketches, which is essential if we are to foster more inclusive participation in multidisciplinary decision-making processes.

Conclusion

This study explored the potential of EnerGPT, a custom generative AI tool, to support foresight-driven design processes addressing urban energy justice challenges. The workshop with a multidisciplinary group showed EnerGPT's value in helping experts structure strategic thinking around complex socio-technical issues. However, some limitations emerged. The participant group, though relevant, did not fully represent all the perspectives needed in real-world decision-making: policymakers, citizens, or community organisations might perceive both the challenges and the tool's utility differently. Additionally, focusing on a single city, (Turin) offered context-specific insights, though results may vary in different geographical or socio-political contexts. These limitations suggest directions for further research: testing EnerGPT and similar tools in broader, more diverse workshops and across different geographical settings. Another reflection concerns the sustainability implications of using generative AI in future-oriented design. While such tools can support envisioning sustainable transitions, their own environmental footprint is relevant and must be considered (van Wynseberghe, 2021). This highlights the need to critically assess the added value of AI in relation to its costs, identifying contexts where its use is justified and most impactful. Overall, our findings highlight the importance of further investigating human-AI collaboration in decision-making processes, involving multiple viewpoints and areas of expertise, with design playing a key bridging role between diverse forms of knowledge and practice.

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