# SAPHEA

## INTEGRATING GEOTHERMAL HEATING AND COOLING NETWORKS IN EUROPE

# Interactive digital guideline ("gamebook") to support the Market Uptake Hub

31. Dec 2024

Author: Marta Fatiga, University of Turin / Giuseppe Mandrone, University of Torino/ Dario Padovan, University of Turin/ Alessandro Sciullo, University of Turin

Deliverable: D6.3 Initial Project Implementation Plan / Version: 4 (feedback from an expert) / Status: Draft
Submission Date: 31. Dec 2024
Supporting Work Package: WP 6
Supporting Team: Veronika Turewicz, Anna Bruestle, Stefan Hoyer
Verified by: GeoSphere Austria, EGEC, TU Vienna & e-THINK
Approved by: General Assembly
Confidentiality level: PU - Public

www.saphea.eu

## Funded by the European Union

| HISTORY OF CHANGES (entered text will be displayed in *this format*) | | |
|---|---|---|
| VERSION | PUBLICATION  DATE | CHANGE |
| 1 | 15.11.2024 | First draft version |
| 2 | 15.12.2024 | First review by partners: revised and changed in the theoretical and methodological framing part |
| 3 | 23.12.2024 | Updated draft, proof-reading and editing (workflow revision) |
| 4 | 31.12.2024 | Feedback from external experts |
| 5 | 15.01.2025 | Feedback from internal reviewers |

## Disclaimer:

# Table of contents

## 1.    Introduction

In today's increasing technological complexity and rapidly changing skill requirements, innovative tools such as gamebooks offer a unique approach to fostering learning and practical problem-solving. In particular, gamebooks stand out for their ability to immerse readers in interactive scenarios, allowing them to explore different solutions and understand the functioning of complex tools or systems through storytelling and decision-making. This methodology is beneficial in situations where users are confronted with advanced technologies or complex systems, such as those related to energy and sustainability.

An emblematic example of this context is the development of a GeoDHC project, which aims to explore and promote innovative solutions for the management of geothermal heating and cooling systems. These systems, which are crucial for the energy transition, require an in-depth understanding of their dynamics to be successfully implemented and utilised. In this context, tools such as gamebooks can facilitate the understanding of these technologies, offering professionals and end users a guided but interactive pathway to acquire practical skills.

This deliverable examines the importance of Game Based Learning (GBL) and gamebooks, with a focus on the Choose Your Own Adventure (CYOA) format. Through theoretical and practical analysis, the paper explores how these tools can support learning, fostering autonomy, adaptability and user engagement. The focus on the SAPHEA gamebook illustrates a concrete application, highlighting the benefits and possible applications in educational and professional contexts, with a specific focus on their integration into innovative projects concerning GeoDHC.

The goal of this deliverable is to create support for the Market Uptake Hub. It will capitalize on the outcomes of the thematic work packages in an easily digestible format and links to the tools of the aforementioned Market Uptake Hub.

The structure will be linear, starting with the general concept of game-based learning and arriving at the specific case of SAPHEA's Choose Your Own Adventure. The steps will be, after the introduction, definition, types, applications and advantages of game-based learning. After that, an *excursus* on the gamebook followed by a description of the SAPHEA gamebook. Finally, before the conclusions, the methodology and steps that led us to the creation of the tool gamebook will be described.

## 2.        *Game-Based Learning*

There are two main concepts related to games with which we should start and between which we should not be confused: game-based learning and gamification. While gamification refers to the application of game-design elements and game principles in a non-game context (such as apps for creating educational quizzes such as Kahoot or Duolingo), Game-Based Learning refers to learning by experiencing the content through the game (Manni & Fenici, 2020); this *model* provides a more experiential reward (learning through fun) (Serious Game: What They Are, Types, and 5 Examples, 2021). The SAPHEA project will be a game-based learning type, with interactive fiction which will guide the users through a few steps to implement a GeoDHC plant.

Why should we use branching narratives for learning? In general, human beings enjoy playing games because they transport them (us) to a space beyond the ordinary, allowing us to escape the thoughts and stresses of daily life. In this realm, we can experience a liberating break from social constraints, roles, and conventional ways of thinking (Manni & Fenici, 2020). According to Manni and Fenici "Introducing games in education has the potential of helping learners develop complex competencies. [...] Games for entertainment are able to motivate learners to stay engaged over long periods through a series of motivational game features."

The motivation they refer to can be distinguished in Intrinsic (individual desires and interests, stimulated through games that challenge individual's abilities) and can be depicted with game-based learning and Extrinsic (carried out by external factors on student's engagement such as badges, points etc..) and they are mostly supported by gamification (Fenici & Manni, 2020). Learners won't be motivated or will have negative reactions to these approaches if: challenges take a long time, or introduce structural or task-related complexities to address.

Finally, according to Hsiao et al. (2014), utilizing games as a teaching and learning tool can a) promote students' learning motivation and eagerness, b) enhance their academic accomplishments and social attainments and c) improve their higher-order thinking skills and critical and cooperative behaviour.

### 2.1. Learning with serious games

Examples of game-based learning include escape rooms for analogue games and serious games for video games, both of which are designed to learn (acquiring new skills by playing). Digital game-based learning approach and serious games, in general, can be utilized as an educational tool which can boost students' well-being and self-esteem, help them improve their soft skills, develop their critical thinking, decision-making and problem-solving skills, as well as maintain a healthy mental and psychological balance. With that view, we presented and analyzed the concept of serious games in education and described the characteristics and features of educational games. We also pointed out the significance of students' motivation and engagement. Finally, we analyzed the

digital game-based learning approach and presented some of its benefits (Anastasiadis, Lampropoulos, and Siakas, 2018).

Gamified design involves the use of game design elements in a context other than entertainment, and it aims for a game-like experience (Landers et al., 2018). More specifically, serious games are complete games, which have clear objectives and they take place in a predefined amount of time (Manni & Fenici, 2020). As we will see, it involves a high level of game design, fosters selective attention, allows strategic choices to be made, and offers an opportunity for a variety of players, including companies, and public administration (PA) (Serious Game: What They Are, Types, and 5 Examples, 2021).

Moreover, in an article written by Anastasiadis, Lampropoulos and Siakas (2018)it is underlined that the increasing popularity of video games has led to their being broadly utilized and applied. In education, for instance, they are mostly applied in the form of serious games.

To understand even more what they consist of, it is good to make some practical examples and list the types of serious games that exist.

- Training and simulations of which a famous example is Just Dance.
- In Healthcare they are used to promote healthy behaviors, educate patients, prevent diseases, and train healthcare workers.
- For HR uses, games are designed to improve soft skills such as leadership, communication and collaboration within an organization.
- Players can develop analytical skills, problem-solving, planning, and analysis through decision-making games. By integrating game mechanics, such as feedback loops, into the learning process, games encourage active participation and problem-solving. These games also facilitate a more hands-on approach to learning, where students (or users-learners) can explore concepts in a dynamic and often less intimidating environment than traditional learning methods.
- Education therefore with a specific purpose: to teach concepts and skills in a fun way. Educational games cover a wide range of subjects, from history to science and mathematics, and can be used in both formal settings such as schools and universities, and more informal settings such as companies or their own homes. Later we will go into this application.

(Serious Game: What They Are, Types, and 5 Examples, 2021).

The benefits of game-based learning include:
1. Motivation: Games naturally captivate learners, keeping them engaged with the content.
2. Collaboration: Many games involve teamwork or multiplayer aspects, enhancing social learning.
3. Adaptivity: Games can be tailored to meet the diverse needs of learners, allowing for a more personalized experience.
4. Immediate feedback: In a game, learners receive instant feedback on their progress, helping them identify areas for improvement.

5. Progression and mastery: Games often feature levels or stages, enabling learners to build upon their knowledge incrementally.

## 2.2 Digital GBL

In general, much literature demonstrates that games improve learning. For instance, as to learning with digital games, Prensky (2001) identified the hallmark of digital game-based learning as the "coming together" of interactive entertainment and purposeful learning through digital games. This approach is inherently student-centred, leveraging digital games to serve educational objectives, including teaching and learning (Perrotta, Featherstone, Aston & Houghton, 2013). Erhel and Jamet (2013) further describe digital game-based learning as a competitive activity aimed at achieving educational goals that enhance knowledge acquisition.

When carefully designed to support the development of cognitive and soft skills, such games—including simulations—offer students a safe, virtual environment to practice and refine their abilities. Furthermore, Ethel and Jamet (2013) and Mayer and Johnson (2010) highlight that effective digital game-based learning environments should incorporate preset rules, clear goals, immediate feedback, and progressively challenging difficulty levels to maximize learning outcomes.

Digital game-based learning (DGBL), is the pedagogical approach of utilizing digital educational games to combine educational content with interactive gameplay. This approach leverages the strengths of gaming (motivation, engagement, and interactivity) to create immersive learning experiences that can improve retention, foster collaboration, and meet diverse learning needs.
Moreover, digital game-based learning offers more benefits to enhance users' learning experience and improve learning and teaching procedures while also promoting active interaction and communication between students and educators. Based on all the above-mentioned facts, some more benefits that digital game-based learning promotes and offers to students:

● Enhanced decision-making and problem-solving skills, as well as critical thinking;
● Improved collaboration and communication environment;
● Positively competitive environment;
● Progressive learning through experience;
● Rewarding feeling of progression and achievement;
● Feedback-driven and student-centred learning.

In summary, DGBL combines entertainment and education, creating a space where learning feels less like a chore and more like an engaging, goal-oriented activity (Spires, 2015).
Educational games, as anticipated, have emerged as a prominent area for the application of serious games in recent years. These games can function as computer-assisted instructional tools that blend skill and chance, leveraging previously acquired knowledge and experiences (Rossiou & Papadakis, 2007). According to Sauvé et al. (2005), educational games are defined as artificially created, imaginative scenarios

where students often face situations of conflict and confrontation, requiring them to either compete or collaborate.

Rossiou and Papadakis (2007) further highlight that educational games are inherently social, governed by predefined rules, and structured with multiple levels of increasing difficulty. As users navigate these levels, they acquire new skills and strategies, overcoming challenges to achieve success while learning. Similarly, Maragos and Grigoriadou (2005) describe educational games as tools that foster logical thinking, skill development, and knowledge acquisition engagingly and enjoyably. These games not only facilitate learning but also immerse students in an entertaining and stimulating environment.

## 3.    Gamebooks

### 3.1 Approaches, models and uses

Starting from the basics, a Gamebook can be defined as a printed fiction that allows the reader to participate in the story by making choices. It belongs to the category of interactive fiction, and it is a form of literature with its own rules and style, which it's more like a game-based way of learning and differs from gamification (Fenici & Manni, 2020).

Gamebooks differ from classic books in the way they are enjoyed: they are, in fact, stories or experiences in which the reader actively takes part in the unfolding of the plot. As mentioned above, readers are confronted throughout the narrative with choices, which change the course of the story and make them more involved in what is happening (Vigamus Academy, n.d.).

### 3.2 Components and Characterising Elements of a CYOA

The first generation of Interactive Fiction was published in the 1970s and 1980s and CYOA novels were part of it, but the story was more linear than the one we are currently used to thinking about; also the targeted age was younger than now (Fenici & Manni, 2020).

The second generation happened between the 1980s and 1990s, and it was an evolution of the Choose Your Own Adventure stories into more structured readings and game systems: the Branching Gamebooks. They had more complex storylines, introduced more choices, and had more choices usually limited to immediate outcomes; this generation of books targeted older readers (Fenici & Manni, 2020).

The third generation was at the turn of the 1990s and the first decade of the 2000s, and they were characterized by a move towards electronic media, these interactive gamebooks re-invented the genre taking inspiration from text-based games and adventure videogames. They introduced more role-playing elements which had an impact on the overall outcome, and more full-colour graphics, and voiceovers (Fenici & Manni, 2020).

The last generation, as mentioned by Marco Fenici (2020), is also named Hybrid Gamebooks and it combines elements from other types of media and technology, they often include social networking features, have complex branching narratives and puzzles to enhance the reader's experience and the end they may have some gamification element (such as achievement systems and leaderboards).

The reader assumes the role of the main character and makes choices that determine the character's actions and affect how the story unfolds. Each story is written from a second person point of view and the narrative is in the present tense. A page is composed of many paragraphs, and in the paper version each of them is usually identified by a number. Each paragraph is composed of a connection with the previously made decision, then there is the main text which pulls forward the story, then some instructions to update the hero's status which is optional and eventually a proposal of a choice to

continue reading at different paragraphs depending on the reader's decision (Fenici & Manni, 2020).

The reader will jump back and forward between paragraphs depending on the decision he/she/it makes, in fact, the narrative branches along various paths instead of following linear page order (Fenici & Manni, 2020). Sometimes in these fictions, it also happens that the reader reads a few pages and then he or she is confronted with two or three choices each of which leads to other options which are associated with numbered paragraphs and which lead to possible endings, usually only one of which can be considered a total success, the others can be failures of the protagonist or partial successes (Fighting Fantasy Game Books, n.d.).

Primarily we define branching narrative as an adventure in which, via Software, an environment is recreated, and in which players can control characters and affect the environment through text commands. Secondly, we proceed to simplify the timeline of Interactive fiction step by step as it comes behind.

Now, we will shortly have a look at the theoretical assumptions on which interactive fictions are based.
For a long time, the game has been identified as highly relevant in education for at least four reasons:
1. The simplifications. While retaining a similarity with reality, it facilitates the apprehension of reality, offering the possibility of grasping its complexity and making it more comprehensible;
2. The total commitment of the players. During the game, it helps each participant to step into the shoes of others and discover points of view, ways of doing things and ways of relating that they would never have access to in "real life";
3. The multiplying trials in successive games. Players can experiment with different possibilities by acting on certain parameters, and assess the consequences without taking risks.
4. Its playfulness. The game can arouse players; interest in an abstract skill, which is then applied to a concrete problem.

### 3.2.1. What interactive fiction models exist

As Marco Fenici (2020) states in the online course held with Riccardo Manni "Teaching the European Union through Game-Based Learning": Interactive fiction is an umbrella term for a variety of formats ranging from choose your own adventures, gamebooks to text-based digital adventures, graphic adventures, and passing through narrative board games.

Mainly, there are three types of gamebooks: the Choose Your Own Adventure, the solo role-playing game adventure modules and the Adventure book game. We will be interested in the former type (CYOA), in which simply the reader's choices determine the more or less successful outcome of the adventure or, in our case, of the installation/investment.

For the sake of knowledge, however, we will summarise the second type as a combination of two-way novels with the rules of a role-playing game for which we need to purchase the manual on which the adventure is based, and the third type as a combination of two-way novels in which certain characteristics are determined by a random mechanism (e.g. the roll of the dice) and during the story some events can be determined by random elements (Angiolino, 2004).

### 3.2.2 For what purposes they are used and adopted (informative, educational, playful, etc)

Continuing to quote the course "Teaching the European Union through Game-Based Learning", co-author Riccardo Manni affirms that "The human need to play has always been linked to our innate desire to experience the world and to test our skills and knowledge on it."(Fenici & Manni, 2020). Wordplay is a system where players are engaged in an artificial conflict defined by rules resulting in a quantifiable outcome (Salen & Zimmerman, 2003).

In a didactic way, gamebooks allow the development of learners' logical and writing skills. Once the initial idea has been decided upon, it is useful to draw a flow chart to manage the possible developments of the story. The book can then be produced in the traditional way or as a multimedia hypertext. As Rita Perrini states in her book *Pianeta scuola. Dalla A come apprendimento alla V come valutazione*, short stories with forks emerged in the late 1950s, although they had educational rather than narrative purposes. The psychologist and behaviorist B.F. Skinner is credited with the conception of books that enabled students to learn without a teacher.

### 3.3 Learning with Gamebooks

As anticipated before, traditional games have long been an integral part of human learning, both in formal and informal contexts, reflecting their enduring role in education (Protopsaltis, Pannese, Pappa, & Hetzner, 2011). Notably, students often demonstrate heightened focus and engagement when participating in computer-based learning compared to traditional school activities. Games provide educators with an effective tool to capture students' attention and actively involve them in educational experiences aimed at achieving specific learning objectives.
Cheng et al. (2013) emphasize that games facilitate knowledge acquisition by enabling students to immerse themselves in role-playing scenarios. As a result, an increasing number of educators are exploring innovative methods to integrate serious games into their teaching practices.

Moreover, serious games possess an intrinsic motivational quality that fosters curiosity and empowers students to feel in control of their learning process (Burguillo, 2010). Motivation plays a crucial role in capturing students' attention and improving their learning performance. According to Erhel and Jamet (2013), the motivational and engaging aspects of serious games are often attributed to their entertainment value, which provides a foundation for both educational and social interaction.

Also in the paper *Jeux de plateau pour l'agriculture et le paysage: Penser, concevoir, animer, évaluer, diffuser* (Dernat, Michelin and Blanche, 2023) the authors reflect on the importance of board games in transmitting knowledge. They suggest that the most important thing to do is to wonder "What is it for?" and "Why does it have importance?" to precisely what motivates the use of one system rather than another. Secondly, the game's finalities have to be clear for everyone to motivate and convince every potential user that the game is the correct and best way to achieve the goal they have. It is also very important to make players want to take part and to give the game process its rightful place, whether as part of a project, a group dynamic, at school or in any other context. (Dernat, Michelin and Blanche, 2023)

The authors propose to classify these games according to four main types of objectives:
- To raise players' awareness of a subject or pass on knowledge to them;
- to get players to "be together" as part of a collective construction, to mobilise and unite players or get them to know and recognise each other;
- to learn to work together, to cooperate with others, or even to co-construct a project or an action (making a project);
- to design and simulate/test technical solutions.

These objectives can be broken down into subcategories (Dernat, Michelin and Blanche, 2023).

In compliance with Dernat, Michelin and Blanche (2023), these objectives can be catalogued in four levels and we need to consider that each of the games can belong to more than one category.

The first level is titled "Using board games to learn or raise awareness", and it aims to improve knowledge and skills, without the players being involved in finding solutions. For instance, they have identified three cases: Level 1A - Games to pass on information, Level 1B - Games for gathering information and exchanging views and Level 1C - Games to train or teach.

The second is titled "Knowing and recognising each other to develop the ability *to act together*" and it is to prepare for action by "being together", with the idea of gradually moving towards a commitment by several people through the game to help develop a collective intelligence or collective skill in favour of action, during or at the end of the game. Here, unlike the first category, the player is concerned by the situation proposed as part of the game, and will even be interested in the results produced as part of the game. At this stage, the aim is to influence the collective dynamic by opening up a space for dialogue that will be conducive to collective action at the end of the game. Also, this level is itemized into: Level 2A - Games for debate and Level 2B - Games to build a shared vision.

The third level is "Cooperating and committing to a project", in this category games that allow several players to consider or decide on actions to be taken and "make a plan" are clustered. In this type of game, the participants are actively involved in the action; the game helps to demonstrate that joint action is possible, but it can also enable participants to progress towards their specific project or action. The game in this section has tangible decision-making and operational implications, by providing an opportunity to discuss the meaning to be given to the action in terms of collective commitment. In

this case, Dernat, Michelin and Blanche (2023) have identified three levels of commitment: Level 3A - Facilitating and supporting collective action, Level 3B - Games for resolving conflicts and negotiating solutions, Level 3C - Games for cooperating and building solutions together.

Eventually, level 4 is titled "Preparing and experimenting in the real world". In this last category, games whose stated aim is to design and test operational solutions right through to their practical implementation are included. Compared to the previous category, the goal here is not just to have the opportunity to act but to use the game to construct an entire decision-making process. Most of the games in this category are linked to design and simulation, they are the closest to reality. This type is distinguished from category 3C by the fact that these games are not centred on co-construction, but on the search for technical solutions. Here the authors identified: Level 4A - Design games, and Level 4B - Games for testing and simulating reality (Dernat, Michelin & Blache, 2023).

It is important to bear in mind that the same game may fall into several of them, depending on the context of use and the players involved. So it's more of an open typology that allows us to ask the right questions than a strict categorisation (Dernat, Michelin & Blache, 2023).

## 4.    SAPHEA gamebook: the CYOA

### 4.1 History of CYOA

As far as the spread of interactive fiction with short stories is concerned, we can frame it in the 1970s.

Tracing the genesis and idea of this concept of books, we can agree that Packard was the originator in 1969, having his daughters participate in the bedtime story: "I had a character named Pete and I usually had him encountering all these different adventures on an isolated island. But that night I was running out of things for Pete to do, so I just asked what they would do" (Scaffedi, 1986). His daughters were very enthusiastic about the idea and the author, being impressed by this, wondered whether it might not be a good idea to put that story in writing and so created *The Adventures of You on Sugar Cane Island* (Scaffedi, 1986). He looked for a publisher in New York and was turned down several times until in 1975 he heard that a new children's publisher Ray Montgomery, co-owner of Vermont Crossroads Press, was looking for innovative ideas and offered his book.

But who was Montgomery? After some experience and work in the field, Raymond Almirand Montgomery founded a summer school that had a programme for children with learning difficulties that was revolutionary for the time (1966) the "Waitsfield Summer School in Waitsfield, Vermont". The programme was based on experience and play and these methods attracted the attention of Abt Associates, a think tank at the University of Cambridge, Massachusetts, founded by Clark Abt and where Montgomery went to work from 1969. The founder of the think tank wrote an influential book in 1970 'Serious Games' that analysed the effectiveness of role-playing for problem-solving (cyoa.com, 2014). This book greatly influenced Montgomery who, when he left Abt, created a role-playing game (The Energy Environment Game) for the Edison Electric Institute that was used in many US high schools during the first energy crisis in 1971 and also other games to train Peace Corps volunteers in cultural awareness and sensitivity (cyoa.com, 2014).

As we said before, in the middle of the 70s, Montgomery was approached by Ed Packard (Kraft, 1981) with a manuscript. Montgomery, recognising the innovativeness of the format, published the book and created "The Adventures of You" series (Scaffedi, 1986). Eight thousand copies were sold, and given the success, "Montgomery was able to make a contract for the series with Bantam Books in 1978. Packard and Montgomery were selected to write books for the series, including the contracting out of titles to additional authors" (Scaffedi, 1986), and here it took the name of Choose Your Own Adventure. The series has roots in game theory and role-playing game simulations. Despite modest initial sales, popularity exploded after 100,000 copies were distributed free of charge in libraries. Between 1978 and 1982, entertainment became interactive, and for many the CYOA books could be considered as the catalyst (Hendrix, 2011). Montgomery attributed the series' success to its interactive concept, which involves behavioural stimulation, problem-solving, and game theory. Readers play a crucial role by making critical decisions that lead to different endings, choosing their own adventures. This approach is seen as a powerful tool for both teaching and entertainment (Lodge, 2007). The series'

non-gender-specific nature, where the reader assumes the role of the hero, ensures a balanced gender distribution among its readers (Lodge, 2007).

Between 1979 and 1999, the series sold over 250 million copies in 38 languages, comprising 184 original books written by 30 authors. The books explored various genres and settings, and the final title of the original series was published in 1998. But the Bantam Books were not the only interactive fiction at the time. The *Tracker Series* of books, for instance, was published in the UK between 1972 and 1980, "These books may well have been the first series of gamebooks (though not the first gamebooks) to be published." (Demian's Gamebook Web Page, n.d.). Moreover, the books in this collection, and generally all gamebooks "are extremely visual; every page of text has an illustration opposite it, and choices may appear either as page numbers in the text or as numbered arrows in the pictures. Puzzles are also included in some of the books." (Demian's Gamebook Web Page, n.d.).

Since 2003, Chooseco LLC has been publishing the series. Chooseco a publishing house located on a Vermont farm, undertook the task of relaunching the series for a new generation of readers. Chooseco is particularly suited for this revival since its co-publisher, R.A. Montgomery, is the original creator of the series. When the series went out of print in 2003, Montgomery decided to revive it under Chooseco, which he founded in 2004 along with his wife Shannon Gilligan (Lodge, 2007). Packard and Montgomery continued to develop new forms of interactive fiction, with Packard creating apps based on his books and Montgomery reissuing old titles and publishing new ones through his new publishing house, Chooseco since in the 1990s, the series lost momentum due to competition and changing reader tastes (Hendrix, 2011). After publishing hundreds of children's books with Choose Your Own Adventure, Montgomery also developed these adventures as games for consoles and software as Comic Creator (cyao.com 2, n.d.). 'Choose Your Own Adventure' has influenced numerous games and media, including Japanese *Bishoujo* video games and role-playing games such as *Dungeons and Dragons*. Even *Mass Effect II* and tools such as *Adventure Player* for PlayStation recognise the influence of the series. Interactive fiction owes much to these books for their popularity and development (cyoa.com, 2014).

Despite its success, the series became notable for its high rate of character mortality. Packard and Montgomery aimed to mirror real life in their stories, deliberately steering away from moralistic conclusions where the "correct" choices inevitably resulted in triumph. This distinctive approach offered a compelling and immersive reading experience, prompting readers to navigate and uncover every possible narrative outcome (Hendrix, 2011).

### 4.2 Learning with CYOA

In the world of Choose Your Own Adventure, applications are various. As we tried to describe before, the employment could be for playful, instructive (as the SAPHEA one is intended to be) and educational purposes. Normally, in books to convey something, the subject matter to be learned is divided into distinct frames ('training frameworks'). At the end of each one, the student must choose an answer from multiple choices. The correct answer leads to the next frame, the incorrect ones to a page explaining what the

error was and directing him to the correct answer. The learning sequence is therefore linear, but the pace of learning depends on the student's ability (Skinner, 1953). Below are some examples of the application of the areas just mentioned.

From the website cyoa.com, it can be seen that 'Choose Your Own Adventure has been cited by numerous educators as a unique and effective way to help students learn to read. The series has documented a popular appeal for the reluctant reader due to its 'interactivity' and that is precisely why we start thinking this method could also serve our purpose.

In the same vein, in 2022 chooseco released their first math workbook, *The Dregg Disaster, an interactive story for the Algebra I gamebook*. *The Dregg Disaster* is an original and cleverly designed interactive story for students learning Algebra I (choose-your-own-adventure-publisher-relaunches-its-website). Another example, in Japan, is the works published by Atama-ii Books which is a Tokyo-based publisher of materials for English language teaching (atama-ii.com, n.d.). Their main products are the *Atama-ii Multi-path Series*, and the *Atama-ii What If? Series* which were awarded for their innovation and efficiency and whose aim is to help Japanese speakers in the process of learning English via interactive narratives, such as gamebooks, or in general gamification of activities and exercises. For instance, in the paper "Reflections on designing and implementing a task-based unit using gamebooks" written by Branden Kirchmeyer and Sarah Faherty we explore how, using Atama-ii gamebooks, activities were designed to engage students in reading English while simultaneously promoting discussions in English (Kirchmeyer & Faherty, 2017). According to this research "the gamebook did serve to increase students' willingness to engage in English activities" and not exactly the facilitation in L2 communicative output they expect (Kirchmeyer & Faherty, 2017).

In addition to being cited by educators for the help that the *CYOA* method gives to students in studying languages and math, as we said a few lines above, it also has found applications in various fields of social sciences, particularly in three other educational contexts to enhance interactive and experiential learning.

One among the others is the teaching of *Information Literacy*. Irene Korber and Jodi Shepherd (2019) explored the use of CYOA flip-books to teach information literacy in higher education. Integrating constructivist theory and active learning strategies, the study highlighted how these interactive narratives can foster learner-centred interactions and effectively engage students in the learning process. This approach allows students to navigate through different scenarios, thus building their knowledge and experiences in a hands-on way (Korber & Shepherd, 2019). Also in *Interactive Fictions and Its Potential in Teaching and Learning* - the broader implications of interactive narrative, in educational contexts, are discussed. It emphasizes how these formats can engage students by allowing them to make choices that influence the outcome of the story, thus fostering critical thinking and decision-making skills (Dodman, Zuidema & Kleiman, 2018)(Kiles, Hall, Scott, & Cernasov, 2021).

Furthermore, according to *Choose Your Own Adventure: Action Research for Professional Development* - teachers also use this method to design their learning experiences according to their interests and needs, effectively enhancing their

professional development through interactive and reflective methodologies and as part of action research projects to improve their practice (Dodman, Zuidema & Kleiman, 2018).

A further application of the gamebook method is in *Pharmacy Education*. Tyler Marie Kiles and colleagues, for example, used the CYOA format to improve pharmacy students' understanding of diabetes management. By transforming traditional patient case studies into an interactive, online CYOA format, the study demonstrated significant improvements in students' knowledge and confidence in ambulatory diabetes management. This method provided a dynamic educational tool that could be adapted to other complex medical conditions to strengthen clinical decision-making skills (Kiles, Hall, Scott & Cernasev, 2021). For example, 'Enhancing Student Knowledge of Diabetes through Virtual Choose Your Own Adventure Patient Case Format' - is a study, published in *Pharmacy*, exploring how the CYOA format was used to teach pharmacy students about diabetes management. The interactive format improved students' knowledge and confidence in clinical decision-making skills, demonstrating the educational potential of CYOA in healthcare education (Kiles et al., 2021). This research examines how CYOA books can be used to support students' social and emotional learning. Furthermore, by putting readers in the protagonist's shoes, these books help develop empathy, problem-solving skills and resilience as students deal with various scenarios and their consequences (Kiles et al., 2021).

Similarly, the article 'Interactive Fiction and Its Potential in Teaching and Learning' discusses the broader implications of interactive fiction, such as CYOA books, in educational contexts. Above all, it is emphasised how these formats can engage students by enabling them to make choices that influence the outcome of the story and thus foster critical thinking and decision-making skills (Dodman, Zuidema, & Kleiman, 2018).

The last one belonging to this set is *Health Communication*. The CYOA method has also been used to create interactive narratives aimed at educating young audiences about health issues. These interactive stories engage users by allowing them to make choices that lead to different health outcomes, thereby enhancing their understanding of health-related behaviours and consequences (Bálint & Bilandzic, 2017).

These examples illustrate the versatility of the CYOA method in educational settings, particularly in engaging students and enhancing their learning experiences through interactive and experiential learning techniques. This method can be adapted to various subjects within the social sciences to improve critical thinking, decision-making, and practical knowledge application.

### 4.3 Fields of application: a few examples

One example among the best practices is "The *ENLARGE*" Horizon 2020 project, which ran from 2016 to 2018, and utilized *CYOA (Choose Your Own Adventure) methodology*, in general, it aimed to generate and disseminate knowledge on collaborative governance with a specific focus on sustainable energy policies. The project was coordinated by the Institute for Social Research, in collaboration with the University of Turin, the European Association for Local Democracy, and the Stockholm Environment Institute in Tallinn.

ENLARGE's primary objective was to develop an interactive knowledge tool on participatory sustainable energy governance that educates public administrators and stakeholders on various participatory approaches, in collaborative processes and their potential outcomes (Ravazzi & Pomatto, 2018). This interactive tool demonstrates how different choices can contribute to or hinder the achievement of positive policy outcomes and the goal was achieved through the creation of the "Choose Your Own Collaborative Adventure in Sustainable Energy" (CYOA) gamebook, which was informed by the project's broader findings and research. Likewise, for the SAPHEA gamebook, the purpose is to supply an orientation and decision support tool in a training way and not didactic because the objective of SAPHEA is not to raise awareness or provide basic knowledge to neophytes but to communicate with people who have at least a minimum of knowledge in geoHC. Likewise, as agreed in SAPHEA's work plan, a Choose Your Own Adventure approach will be adopted in this task with the clear objective of building one's own path to the end of the game. To achieve this goal, all the tools made available by SAPHEA will be touched upon, going through all the steps for building a geothermal infrastructure, without forcing a linearity that does not exist in reality and therefore the order of the steps may differ somewhat between one player/promoter and another. The aim is not to merely create an interactive guide that would be much closer to a set of FAQs than to a gamebook.

In the specific case of ENLARGE, the CYOA gamebook was developed following a comprehensive review of existing collaborative approaches in sustainable energy, distinguishing between participatory and deliberative processes. Participatory processes aim to mobilize citizens to directly influence political decisions, while deliberative processes create public discussion spaces to make decisions in a constructive and consensual manner (Ravazzi & Pomatto, 2018).

This game-book begins with an introductory conflict and provides essential information about the fictional setting and it emphasizes the complexity of public policy implementation. The narrative involves a series of scenarios that change depending on the choices made at specific decision points by the reader (39 sections), who can play the role of the mayor or an executive member of the local government. They have decided to involve citizens in the planning and implementation of a sustainable energy improvement plan for their community; the various scenarios, as well as sustainability, highlight the impact of their choices on the legitimacy and effectiveness of collaborative processes. The book also details the objectives and interests of the actors involved, the outcomes of collaborative choices in terms of social legitimacy, institutional sustainability, policy effectiveness, and solutions to mitigate any negative outcomes.

Actors, who often have conflicting interests, in the gamebook are categorized into five types based on their main interests and types of rationality: local politicians, bureaucrats, actors concerned with general or special interests, and experts. The collaborative processes are significantly influenced by design choices, contextual conditions, and events occurring during the process. To reveal the diverse consequences of context conditions and design choices, the CYOA gamebook features multiple pathways and decision points, allowing readers to explore different project choices if initial ones do not yield the expected outcomes.

Specifically, readers who engage in the co-design of the wind farm have several alternatives available to them regarding: the timing and intensity of citizen involvement

(e.g. early and extensive vs. limited involvement), the governance model of the co-design process (e.g. political leadership and internal management vs. creation of a stakeholder committee and involvement of external public participation professionals), the types of citizen involvement (e.g. Participatory processes, deliberative processes or hybrid processes), the conclusion of the decision-making process on emerging issues (e.g. with a vote on proposals, with a report subject to city council approval or with both), the strategies for citizen involvement (e.g. material vs. immaterial incentives) and the strategies for maintaining citizen involvement (e.g. engagement management by public officials vs. peer-to-peer mentoring by trained citizens).

The ENLARGE game book realistically represents the multiple factors influencing collaborative processes by placing readers in the roles of different actors. This allows them to understand different objectives and perspectives and to see the consequences of their choices in terms of social legitimacy, institutional sustainability and effectiveness of collaborative processes. The possibility to change initial choices and explore alternative options is particularly appreciated, as politicians and public officials often do not directly see the consequences of their actions or inactions.

In conclusion, through its innovative CYOA game book, the ENLARGE project represented a significant step towards improving collaborative governance in sustainable energy policy-making by putting readers in the shoes of various stakeholders to understand different objectives and perspectives. Offering an interactive tool for public administrators, ENLARGE emphasises the importance of thoughtful decision-making to achieve social legitimacy, institutional sustainability and policy effectiveness. By exploring different choices and their outcomes, readers can understand the complexities of public administration and the importance of inclusive and participatory governance in sustainable energy planning. Moreover, 79% of users would recommend the CYOA gamebook or other ENLARGE materials to anyone interested in undertaking or improving collaborative processes in the field of sustainable energy, and SAPHEA, with its gamebook, has the same goal.

### 4.4 The SAPHEA CYOA Description

### 4.4.1 Why a gamebook in SAPHEA

*Developing a gamebook as part of a project like SAPHEA makes sense for several reasons, related both to the nature of projects in general and to the specific challenges SAPHEA faces.*

On the general side, projects tend to produce a large number of results, often complex and difficult to disseminate effectively and transfer to end users. A gamebook can be an innovative and engaging tool to facilitate access to the most relevant information, making the content more usable and immediate.

In the specific case of SAPHEA, the challenge is particularly multidimensional, involving technical, social, economic and environmental aspects, all equally important and closely interconnected. However, this complexity makes it difficult to navigate the different priorities and stages of the process (e.g. what to tackle first and what later). A gamebook could help represent these connections clearly and intuitively, guiding readers

through the different dimensions of the project and helping them understand their relationships.

Moreover, SAPHEA addresses a variety of potential audiences, each with different needs, prior knowledge and goals. It is not easy to design a single path that is effective for everyone. A gamebook, thanks to its interactive and customisable structure, makes it possible to adapt the training path to the needs of each user, offering tailor-made experiences that take into account different perspectives and levels of insight.

Finally, as envisaged in the agreement the gamebook aims at informing users on issues, uncertainty and consequences of the choices made by decision-makers. It will transfer results produced by the thematic WPs to an intuitive and easy-to-use interactive guide to support market actors in building their pathways towards future geoHC networks. The gamebook will be inspired by the "CYOA approach" and it will offer an opportunity to simulate geoHC network implementation processes based on the scenarios developed in WP2. As we said before, the adventure will predefine the identification of the individual market actor profile and that will be the starting point. The gamebook will interactively guide the user step-by-step through the planning and decision-making steps to be performed, with tailored options, which interlink with the individual tools of the Market Uptake Hub.

## 5. Methodology

SAPHEA CYOA methodology is composed of 5 main steps

Step 1 – Target profiling
Step 2 - Mapping tools and resources produced by the project
Step 3 – Design of the CYOA
Step 4 - Implementation
Step 5 - Validation

In the following section, we will analyze step by step the process of the draft of the SAPHEA gamebook. As demanded in the Grant Agreement we profiled the target at a local/national level and international too, after that we analyzed and selected the Deliverable on which we should have focused (as agreed upon the deliverable had to belong to WorkPackages 2 to 5). As the third step came the design of the structure and consequently of the *tale* and the pathways, followed by implementation (it will consist of two parts: analysis and software design and implementation), and eventually the validation in two steps; the first ongoing the process of drafting, while the second subsequently.

### 5.1 Step 1 – Target profiling

As written in the Grant Agreement in the section of *Key element of the impact* - Target groups there is a precise list of stakeholders who will benefit from the project results; the main two groups are *Local to national* and *International stakeholders*.

To this differentiation, we have combined a categorisation on an institutional level: public administrations, energy utilities & communities and researchers and academia, according to what is written in the Agreement in section *1.2.4 Inclusion of open science practices* in *Part B: Technical description*. We also added policymakers national/EU level and civil society to be more specific and clear.

Last but not least we also classified the stakeholder function, as in the agreement, as a strategic partner, adopter, multipliers, decision maker and other. So the combined list will be like the following:

Local to national stakeholders
- Public administrations and public service providers (planners, authorities) – LS1 - Adopter - public administrations
- Public and private energy suppliers and related service providers – LS2 - Affected - energy utilities & communities
- Policymakers and sectoral agencies dealing with energy and climate strategies – LS3 - Decision Maker - policymakers national/EU.
- Communities and councils including residents involved or affected by geoHC networks – LS4 - Multipliers - civil society
- Financial service providers and energy contractors – LS5 - Strategic Partner

- Energy communities in the HC sector – LS6 - Other - energy utilities & communities
- Research and academia linked to the HC sector – LS7 - Strategic Partner (Adopter?) - researchers and academia.

International stakeholders
- International civil society organizations including, interest groups and research networks linked to the HC sector – IS1 Adopter, Multiplier - civil society
- EU institutions and policymakers linked to the HC sector – IS2 - Decision Maker - policymakers national/EU
- Financial service providers and energy contractors – IS3 - Strategic Partner
- International projects addressing research topics linked to geoHC networks – IS4 - Multiplier - researchers and academia
- Interested lay public (indirect) – IS5 - Other

5.2 Step 2 - Mapping tools and resources produced by the project (supply side)

In this step, we will list and describe the main SAPHEA tools, to be considered in the CYOA. Also in this case we certainly will follow the instructions written in the Grant Agreement "The gamebook will constitute a web-based compilation of fact sheets and self-assessment questionnaires compiling the results of the thematic work packages WP2 to WP5", and the following table was obtained from the information present in *Part B: Technical description* of the Agreement. More precisely in section *2.1.1 Expected project results.*

| Category | Tool | Description | Deliverable |
|---|---|---|---|
| Technical | Scenarios | Heating and cooling supply scenario catalogue in the context of proven and future technological concepts | D 2.2 |
| Technical | GIS tool | Catalogue of spatial datasets including data preparation guidelines and protocols | D 2.3 |

| | | | |
|---|---|---|---|
| Technical | Hotmaps | The white book of the spatial dataset-related toolbox | D 3.1 |
| Technical | Hotmaps | Open-source toolbox for early-stage investment decision support and strategic planning | D 3.2 |
| Financial | Financial Tools | Status report on financial mechanisms/schemes relevant to geoHC networks | D 4.2 |
| Financial | Financial tools | Blueprints of financial mechanisms relevant to geoHC networks | D 4.4 |
| Economic | Business Models | Status report on business models relevant to geoHC networks | D 4.1 |
| Economic | Business Models | Blueprints of business models relevant to geoHC networks | D 4.3 |
| Economic | Key Market Drivers | Status report on key market drivers related to the implementation of geoHC networks | D 2.1 |
| Socio-Economic | Parameters to perform socio-economic impact | Catalogue of spatial datasets including data preparation guidelines and protocols | D 2.3 |

| Social | Social Readiness | Status report on the socio-environmental conditions for the implementation of geoHC networks in Europe | D 5.2 |
|---|---|---|---|
| Regulatory | European Status Quo | Status quo report on regulatory and policy framework in the context of geoHC networks in Europe | D 5.1 |
| Regulatory | Recommended measures | Science to policy report on recommended measures towards a supportive regulatory and policy framework | D 5.3 |

Table 1: List of tools and deliverables useful for the *gamebook*

In steps 4.1 and 4.2, we will show the succession of these deliverables according to a pattern proposed to the partners.

### 5.3 Step 3: Design

We chose to describe in three phases the design step: I. creating and constructing the structure, II. involving setting the environment and III. delineating the pathways.

*Step 3.1: Designing and building the structure*

More precisely in this step, we consulted two experts and together we tried to understand how to proceed. We knew what was supposed to be in each of the deliverables, but we needed to understand deeply the functioning of each tool produced in the SAPHEA process. So different partners were asked to compile a Situation-Task-Action-Result model (which will be better described later, see Annex 2). In this way, we have been provided with examples easier to understand and very useful for drafting the story and making each tool efficacious for any kind of user.

*Step 3.2: Setting the environment*

A workflow was defined from the start to the building of the geoDHC; to achieve the purpose, the gamebook will use the deliverable tool from the SAPHEA project. In this part we started to focus on the possible story we could follow: the protagonist will make a decision between implementing an existing or non-existing public heat distribution system while pursuing the goal of decarbonizing thermal energy.

*Step 3.3: Drawing the pathways*

Eventually, we will utilize the first pathway we drew (the major one) as a scheme to follow to declinate the other two profiles' routes (for company and consultant). The workflow will more or less be the same dwelling on different points for each of the three characters.

## 5.4 Step 4: Implementation

As anticipated this step will be separated into two substeps: the process of analysis (in turn will be divided into two) and Software design and implementation in Twinery (an easy-to-use software for creating interactive fiction).

*Step 4.1 Process of analysis*

Step 4.1.1

The workflow mentioned earlier is derived from an internal debate between members of the SAPHEA consortium. The *gamebook* will use the deliverable tool of the SAPHEA project to achieve the purpose of decarbonizing thermal energy. We also divided it into chapters to make the passages clearer.

In chapter 1 users have a brief introduction about the setting of the story per se, and some basic knowledge about decarbonization and renewable to let the protagonist understand what are the strengths and weaknesses of a geoDHC. In the second chapter, the gamebook will propose to have a look at the key Market Drivers which are presented in D2.1, and after this in-depth examination, the reader will be asked whether he/she is still convinced to plan the building of a geoDHC, and if yes, he/she will proceed with the chapter 3. Here the player will explore the geothermal potentiality (D3.1) of an area and having assumed an awareness he/she will consult a catalogue of the best and possible scenarios for implementing a geoDHC plant, presented in deliverable 2.2 and it considers geothermal resources and thermal energy needs.
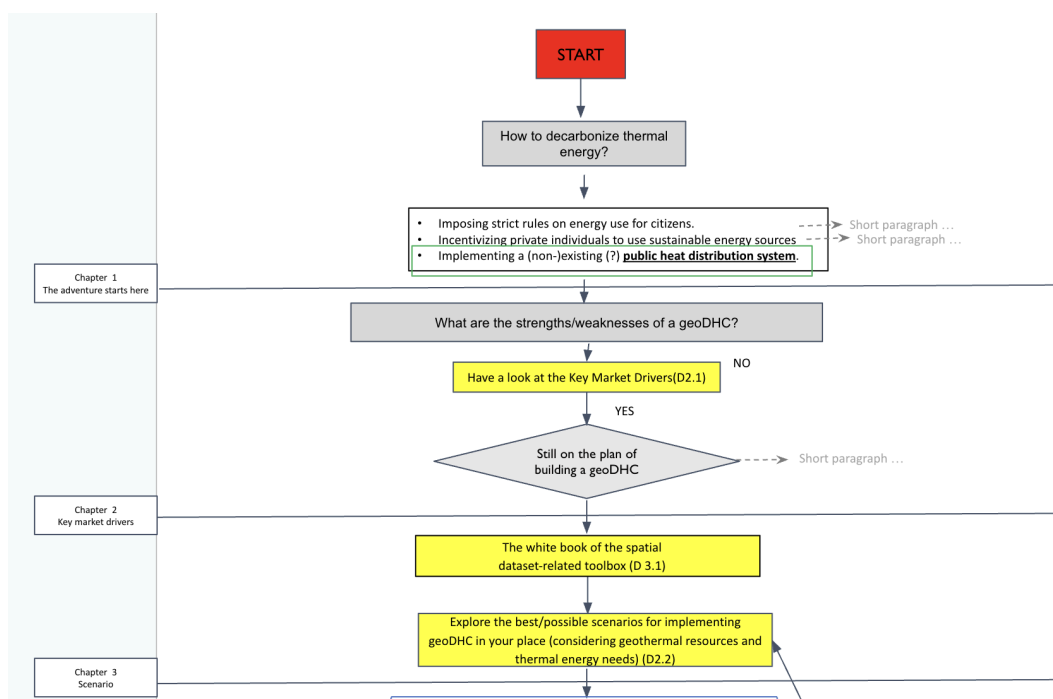
Fig.1 Gamebook's workflow scheme pt.1

As shown in the following figure (fig.2), provided in the story (Chapter 4), the user will have two options for path:

- Check which protocols and technical features should be considered for your scenarios to be implemented (D2.3)
- Perform a FIRST assessment of the societal readiness and sustainability of the different scenarios (D5.2)

In both cases, the player will anyways analyze the other deliverable and then will be routed to Chapter 5 to identify the most suitable, feasible and sustainable scenario, you need to check for investments and costs (described in D3.2). After that, the user is asked whether he or she is still convinced of the scenario he or she thought of earlier after checking the feasibility. If they had changed their mind about the scenario, they were first asked to analyse D2.2 again and to redo the game up to that point. Otherwise, if the answer was positive the player will check the regulatory and policy framework proposed (Chapter 6) and described in D5.1. Then, the natural continuation would be to consult deliverables D4.1 and D4.2 which then lead to D4.3 and D4.4 respectively, and that being done the reader is suggested to check the other deliverables of the same chapter 7 (as shown below).
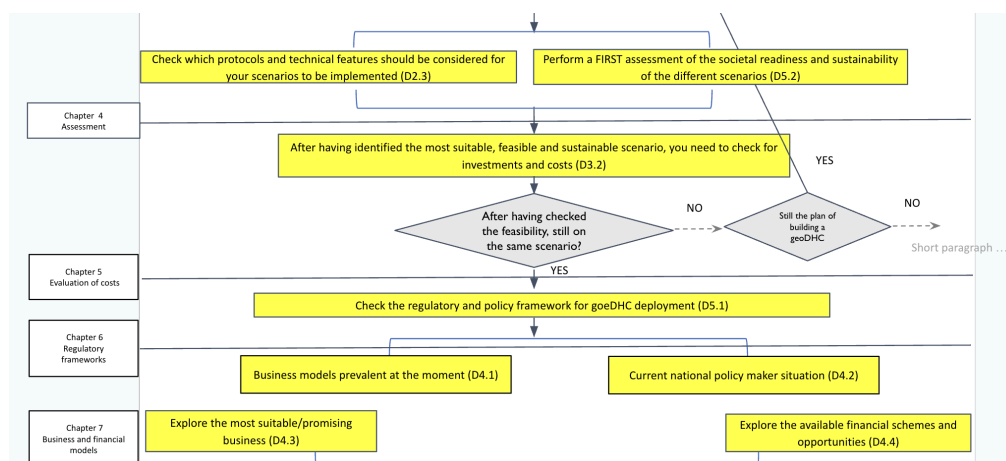
Fig.2 Gamebook's workflow scheme pt.2

Eventually, to complete the process, in Chapter 8 it is suggested to perform a second assessment of the sustainability of the project through citizen engagement (D5.2). If the reader is still on the plan of building a geoDHC, now he/she will be ready to build it, with consciousness and more tools at disposal.
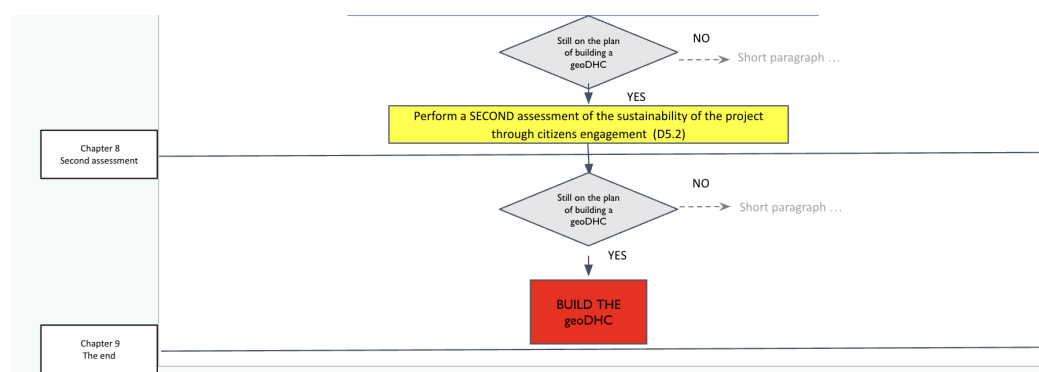


Fig. 3 Gamebook's workflow scheme pt. 3

Step 4.1.2

As anticipated in this section at step 3.1, as a team, we were asked to fill in a template "STAR model" that can be described as a table of four lines: one is *Situation*, then we have a Task, then *Action* and eventually *Results*. Each partner was asked to compile at least one model per deliverable they were responsible for, furnishing a concrete example of the tool's application. In that way, they provide us with concrete examples of the application of their tools, which in step 4.2 will be used for the implementation of the gamebook. In the appendix, you will find some examples of the SAPHEA STAR models.

*Step 4.2 Software design and implementation (Twinery)*

We chose to use the twinery.org platform and now we explain its history, what it is and what it is used for.

Twine is an open-source software designed to create non-linear interactive stories, storytelling games or text experiences. Originally developed by Chris Klimas in 2009, Twine has become a popular tool among writers, game designers and artists who wish to experiment with branching narratives without necessarily possessing advanced programming skills.

Key features
1. Intuitive interface
Twine offers a node-based visual editor that allows you to build stories through a map of connected passages. Each passage represents a scene, description or interaction within the narrative.

2. Simple markup language
Stories in Twine are written using a markup language called Harlowe, which allows text to be formatted, hyperlinks to be inserted and interactive elements to be added. Other supported story languages include SugarCube, Snowman and Chapbook, each with special features.

3. Multimedia and customisation
Twine supports images, sounds and videos, allowing authors to enrich their creations. In addition, HTML, CSS and JavaScript can be used to customize the appearance and behaviour of stories.

4. Simple export
Projects created with Twine can be exported as HTML files, making them easily shareable and accessible on any web browser.

So what is the purpose of Twine? The platform is particularly useful for:

- Writing interactive stories is perfect for authors who want to explore multiple narrative paths.
- Prototyping games are perfect for game developers who want to create narrative prototypes without committing to complex programming right away.
- Educational material can be used to create interactive educational experiences, quizzes or guided tours.

Thus, the accessibility (free and available on various operating systems) and ease of use make Twine an appropriate choice for the work we do with SAPHEA.
In conclusion, Twine is a powerful tool for anyone wanting to explore the potential of interactive storytelling. Its ease of use and flexibility make it ideal for both beginners and professionals, opening up creative possibilities in the world of interactive stories and narrative games.

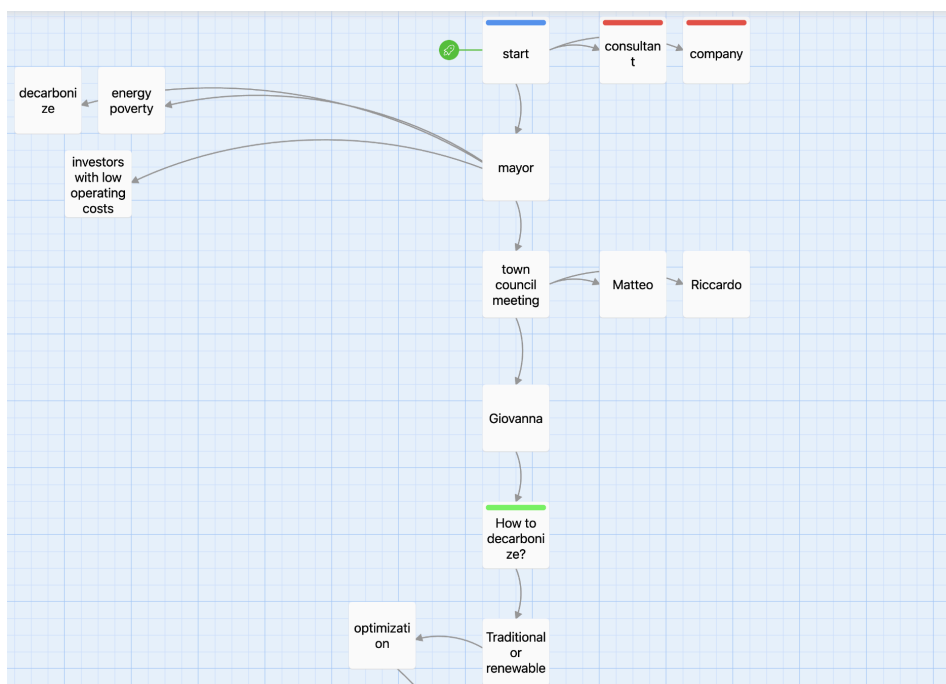Below we provide a visual example of our project.

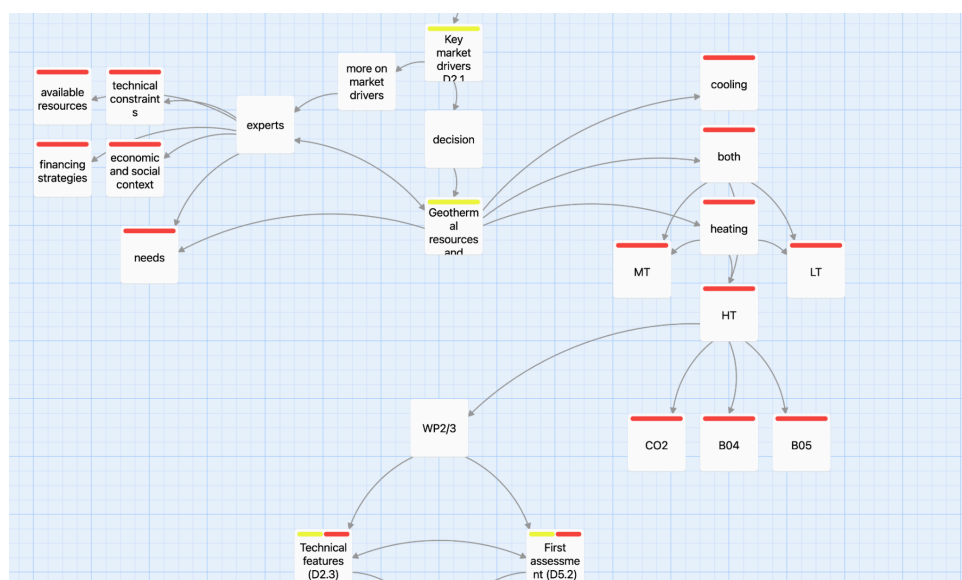Figure 3: Part of SAPHEA's Twine interface with connected nodes



Figure 4: Part of SAPHEA's Twine interface with connected nodes

A typical project in Twine looks like this, as a visual map composed of connected nodes. This representation helps the authors, i.e. us, to maintain control over the various narrative paths and to identify any inconsistencies or opportunities for further investigation. Above we can see two focuses on some of the several steps that will compose the SAPHEA gamebook. The specific case of Figure 3 represents the starting point and the "How to decarbonize thermal energy?" section of the Workflow (step 4.1). What concerns Figure 4, instead, is outlined in the second part of Figure 1 and therefore the exploration of D2.1, D2.2, D2.3 and D5.2. Each of these passages is developed on twine as it is shown below.
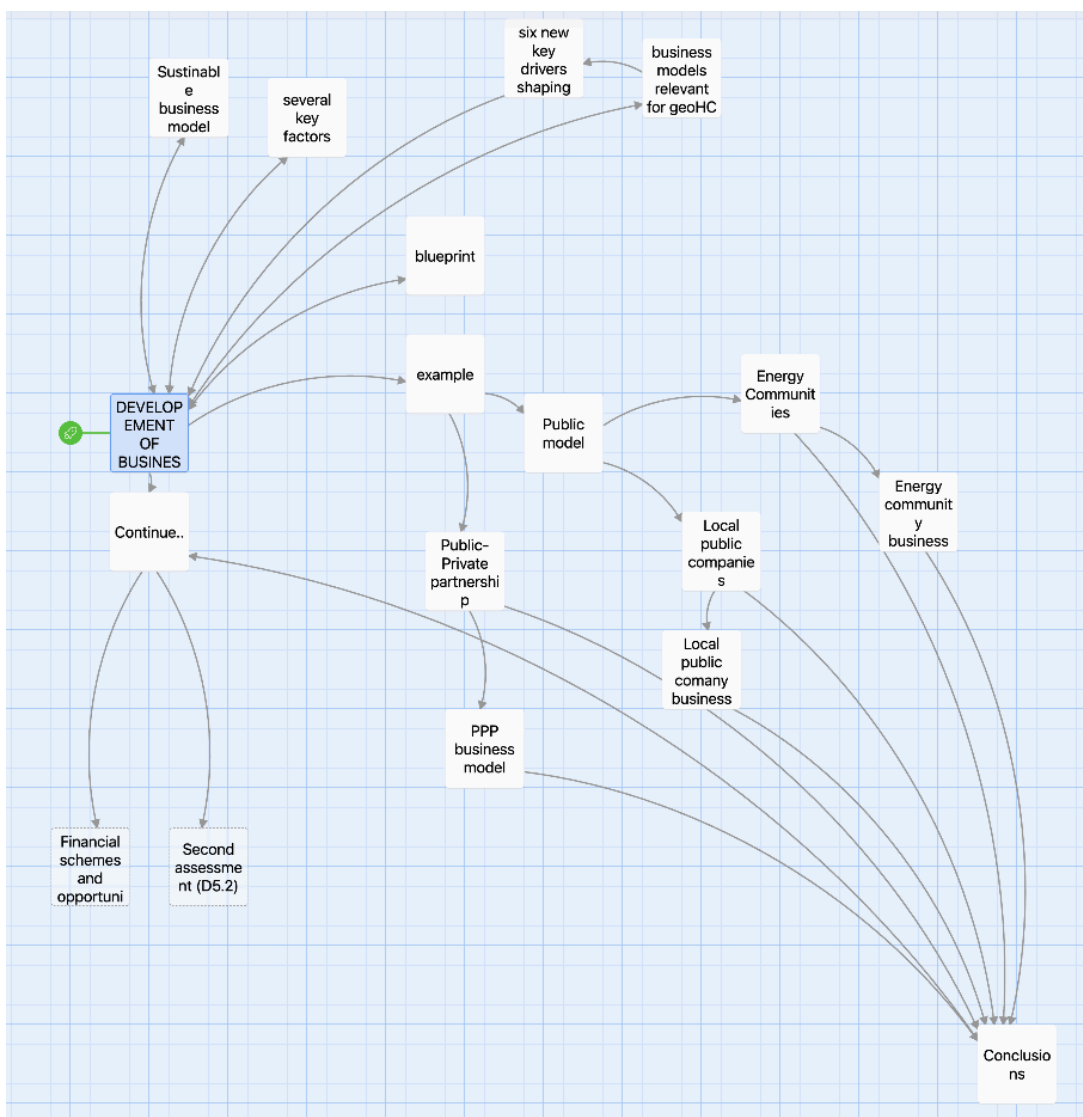
Figure 5: Background of D4.3 Competitiveness of the Development of Business Model Blueprints for the geoHC Networks Industry

This deliverable, for instance, addresses the topic of business model blueprints. Evaluated that not every user will be informed enough about what financial and business models are, we propose some glossary (on top: Sustainable business model, key factors, blueprint, business model relevant for geoHC) so that the player can click on the links (Figure 6) and understand what they are talking about in that deliverable.



"Hi Adam, after you checked the regulatory and policy framework for geodhc depleyment you should have a look at the promising **sustainable business model**" says Armando.

The evolution of business models in the geothermal sector has been influenced by **several key factors**, and in the SAPHEA deliverable 4.1 are listed **business models relevant for geoHC networks** .

You can **continue** on your deliverable journey or check this **example** which shows the usefulness and existence of a **blueprint** business model.

Figure 6: Front of the first step of D4.3

As shown here, in each of the *cells* of Fig. 5 there is a part of the story written and the links we were talking about are the blue ones, clicking on each of them the users will be relocated to another branch; in this way, the story will be able to be thorough or to continue; for example, tapping *example*, and in that case, the illustrative case will be supplied.

In each of the chapters the opportunity to directly go to another deliverable, instead of browsing something they already know, will be given.

*Step 4.3 - State of play of gamebook implementation and next steps (31.12.2024 )*

*The first version of the gamebook for the major pathway is available at URL....*

To date chapters 1 to 3 have been released (*click on the following HTML code to have an idea of how it works* SAPHEA gamebook v1.6.html )

Chapters 4 – 9 will be implemented as long as the deliverables and tools are finalized, tested and published. The expected timeline for the completion of the GB implementation is reported in the table below.

| Chapter | Description | Deliverable | Date of release |
|---|---|---|---|
| 1. The adventure starts here | The chapter will introduce the topic and the setting of the story. | XXX | Released |
| 2. Key market drivers | In this section, the reader will verify the advantages and weaknesses of a GeoDHC. | D2.1 | Released |
| 3. Hotmaps and scenarios | In this part, the user will understand what scenarios and geothermal potential are and which ones are best suited to his or her context. | D3.1 and D2.2 | Released |
| 4. Assessment | The chapter will guide the reader through the different tools and concepts for assessing project societal readiness and the technical tools he or she will need. | D 2.3 and D 5.2 | February 2025 |
| 5. Evaluation of costs | In the passage, the player will check for the cost and investments. | D3.2 | February 2025 |
| 6. | In this Branch regulatory and | D5.1 | February 2025 |

| | policy frameworks will be studied. | | |
|---|---|---|---|
| Regulatory frameworks | | | |
| 7. Business and financial models | In this part business and financial models, existing and non, will be taken into account and will be assessed. | D4.1, D4.2, D4.3 e D4.4 | February 2025 |
| 8. Second assessment | Feasibility from a societal and economic readiness point of view will be evaluated. | D5.2 | February 2025 |
| 9. The end of the adventure | If the reader has come this far he/she will have every useful tool to implement a geoDHC. | XXX | March 2025 |

Tab. 2: Chapters description and timeline

## 5.5 Step 5: Validation

SAPHEA GB is composed of the tools produced by the project and aimed at supporting their use for competent but not mandatorily expert users. Its effectiveness relies therefore on a right balance between robust and reliable description of the tools and friendly interface. In order for this balance to be guaranteed the project team designed a proper validation activity composed of two complementary perspectives (and steps):

- *Internal*, involving experts and/or the SAPHEA partners responsible of the SPAHEA tools)
  The internal validation was realised in parallel with the development of the gamebook on the Twine platform. For each deliverable, we created components on Twine, and we tested them with partners who were leaders for the corresponding report. We asked them for feedback and advice on the development of the branching, and on the correctness and completeness of the IT implementation. They supported the CYOA team in the simplification of the passages and the tale and in making it more comprehensible.
- *External*, involving final users and/or the SAPHEA consortium
  The external validation is being implemented taking into account the users' perspective in order to assess three main characteristics:
  - *Browsability*: ease of navigation (moving back and forth among the chapter and sections)
  - *Functionalities*: accessibility to SAPHEA tools and related instructions
  - *Self-orienting*: awareness about users' position in the CYOA world and along the implementation pathways

  Use tests are performed by both internal and external users including stakeholders are being implemented.

# 6.    Conclusions

The report has highlighted the crucial role of gamebooks and Game Based Learning (GBL) in promoting dynamic and user-driven learning. Thanks to their interactive and narrative structure, gamebooks not only stimulate interest and participation but also provide a safe environment in which users can explore decisions and consequences, learning practically and experientially. The case of the SAPHEA gamebook demonstrates how the Choose Your Own Adventure format can be adapted to address educational and professional challenges, from improving decision-making skills to familiarizing oneself with complex tools.

A significant example of the potential of gamebooks emerges in the context of the GeoDHC project, which aims to raise awareness and train users in the use of geothermal heating and cooling systems. These systems, while offering sustainable and efficient solutions, can be complex for non-experts. In this scenario, gamebooks represent an ideal bridge between the user and the technology, facilitating the learning of their functionality through narrative and interactive experiences.

Gamebooks also stand out for their ability to transform technical and theoretical content into accessible and engaging experiences, making them ideal for training users who have to juggle unfamiliar tools or systems. In addition, they offer a customisable approach, allowing content to be adapted to the specific needs of the user, improving comprehension and long-term memory.

Prospects for the use of gamebooks and GBL are broad and promising. As technology and digital storytelling techniques evolve, these tools can be further enriched with elements of augmented reality, artificial intelligence and advanced personalisation. In the case of applications such as those proposed by the GeoDHC project, integration with advanced digital platforms could enable even more realistic and targeted simulations.

Ultimately, the integration of GBL and gamebooks represents an extraordinary opportunity to rethink the way we learn, fostering not only the acquisition of knowledge but also the development of critical skills to face the challenges of an ever-changing world. Projects like GeoDHC highlight how these technologies can be applied in specific and innovative contexts, helping to create a sustainable and conscious future.

# Bibliography

Anastasiadis, T., Lampropoulos, G., & Siakas, K. (2018). Digital game-based learning and serious games in education. *International Journal of Advances in Scientific Research and Engineering, 4*(12), 139-144.

Angiolino, A. (2004). *Costruire i libri-gioco: come scriverli e utilizzarli per la didattica, la scrittura collettiva e il teatro interattivo*. Sonda.

Branden, K. I. R. C. H. M. E. Y. E. R., & Faherty, S. (2017). Reflections on designing and implementing a task-based unit using gamebooks. 崇城大学紀要, *42*, 183-191.

Burguillo, J. C. (2010). Using game theory and competition-based learning to stimulate student motivation and performance. *Computers & Education, 55*(2), 566-575.

Cheng, Y. M., Lou, S. J., Kuo, S. H., & Shih, R. C. (2013). Investigating elementary school students' technology acceptance by applying digital game-based learning to environmental education. *Australasian Journal of Educational Technology, 29*(1).

Dernat, S., Michelin, Y., & Blache, N. (2023). *Jeux de plateau pour l'agriculture et le paysage: Penser, concevoir, animer, évaluer, diffuser* (p. 179). éditions Quae.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design elements to gamefulness: Defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9-15).

Dodman, S., Zuidema, E., & Kleiman, A. (2018). Choose Your Own Adventure: Action Research for PD. *Educational Leadership, 76*(3), 72-76.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education, 67*, 156-167.

Hendrix, G. (2011). Choose your own adventure: How the Cave of Time taught us to love interactive entertainment. *Slate*. Recuperato da https://www.slate.com/articles/arts/culturebox/2011/05/how_the_cave_of_time_taught_us_to_love_interactive_entertainment.html.

Hsiao, H. S., Chang, C. S., Lin, C. Y., & Hu, P. M. (2014). Development of children's creativity and manual skills within a digital game-based learning environment. *Journal of Computer Assisted Learning, 30*(4), 377-395.

Kiles, T. M., Hall, E. A., Scott, D., & Cernasev, A. (2021). Enhancing student knowledge of diabetes through virtual choose your own adventure patient case format. *Pharmacy, 9*(2), 87.

Kraft, S. (1981). He chose his own adventure. *The Day, 6*.

Lodge, S. (2007). Chooseco embarks on its own adventure. *Publishers Weekly, 17*.

Maragos, K., & Grigoriadou, M. (2005). Towards the design of intelligent educational gaming systems. In *Proceedings of the AIED05 Workshop 5: Educational Games as Intelligent Learning Environments* (pp. 35-38).

Mayer, R. E., & Johnson, C. I. (2010). Adding instructional features that promote learning in a game-like environment. *Journal of Educational Computing Research, 42*(3), 241-265.

Perrini, R. (2002). *Pianeta scuola. Dalla A come apprendimento alla V come valutazione*. Armando Editore.

Perrotta, C., Featherstone, G., Aston, H., & Houghton, E. (2013). *Game-based learning: Latest evidence and future directions*. Slough: NFER.

Prensky, M. (2001). Digital game-based learning. *Computers in Entertainment (CIE), 1*(1), 21-21.

Protopsaltis, A., Pannese, L., Pappa, D., & Hetzner, S. (2011). Serious games and formal and informal learning. *E-learning papers, 1887*, 1542.

Ravazzi, S., & Pomatto, G. (2018). Choose your own collaborative adventure in sustainable energy.

Rossiou, E., & Papadakis, S. (2007). Educational games in higher education: A case study in teaching recursive algorithms. In *Proceedings of the Fourth International Conference on Education in a Changing Environment* (Vol. 149157).

Sauvé, L., Renaud, L., Kaufman, D., Samson, D., Bluteau-Doré, V., Dumais, C., ... & IsaBelle, C. (2005). *Revue systématique de écrits (1998-2004) sur les fondements conceptuels du jeu, de la simulation et du jeu simulation*.

Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction. *Computers in Human Behavior, 69*, 371-380.

Salen Tekinbas, K., & Zimmerman, E. (2003). *Rules of play: Game design fundamentals*.

Spires, H. A. (2015). Digital game-based learning. *Journal of Adolescent & Adult Literacy, 59*(2), 125-130.

## Sitography

Atama II. (n.d.). *Home*. Atama II. Retrieved from https://www.atama-ii.com/home/.

Demian's Gamebook Web Page. (n.d.). *Series*. Demian's Gamebook Web Page. Retrieved from http://www.gamebooks.org.

Fenici, M., & Manni, R. (2020). *Teaching the European Union through Game-Based Learning*. Tracker Books.

Chooseco. (2019). *Chooseco relaunches its website*. Chooseco. Retrieved from http://www.cyoa.com.

Chooseco. (2023). *Current developments in Choose Your Own Adventure*. Chooseco. Retrieved from http://cyoa-experience.com.

cyoa.com. (n.d.). *History of CYOA*. Chooseco. Retrieved from http://www.cyoa.com.

cyoa.com. (n.d.). *R. A. Montgomery 1936-2014 – Chooseco LLC*. Chooseco. Retrieved from http://www.cyoa.com.

Fighting Fantasy Game Books. (n.d.). *What is Fighting Fantasy?*. Retrieved from https://web.archive.org/web/20090526080820/http://www.fightingfantasygamebooks.com/whatis.htm.

Serious Game: What They Are, Types, and 5 Examples. (2021). *Serious Game*. Retrieved from https://www.seriousgame.com/cosa-sono.

Vigamus Academy. (n.d.). *Interactive Fiction: Origins and Secrets*. Vigamus Academy. Retrieved from http://www.vigamusacademy.com.

Annexes

Annex 1 - Narratives

Narratives

For each institutional level, we have written the skeleton of the tale:

1) Public administrations (PA)
A PA wants or must decarbonize its energy system, specifically H&C. The PA would like to consider using geothermal energy in DHC but has no expert on it.

The PA energy/environmental officer looks for some user-friendly guidelines to understand what he/she needs to assess if they could integrate geothermal energy in their territory and comes across SAPHEA MUH & Gamebook CYOA.

The PA energy/environmental officer navigates the gamebook and learns what steps he/she needs to go through to assess the feasibility of integrating geothermal energy in their territory.

She/he discoverers useful resources for early-stage geoDHC investment decision support and strategic planning on the SAPHEA MUH to evaluate the pre-feasibility of integrating geoDHC in their area, such as guidelines on the Knowledge Base, available datasets and tools, strategies and best-practice example of how geothermal energy can help decarbonize H&C.

2) Energy utilities & communities
An energy utility/community would like to consider adopting geothermal energy and might have geothermal experts, or engineers with technical competencies of H&C planning and technical/economic assessment.

The energy utility/community officer looks for guidelines to start its assessment of integrating geothermal energy in their area and finds the SAPHEA Gamebook CYOA.

The energy utility/community officer navigates the gamebook and learns what steps he/she needs to go through to assess the feasibility of integrating geothermal energy in their area.

She/he discoverers useful resources for early-stage geoDHC investment decision support and strategic planning on the SAPHEA MUH that she/he could use to evaluate the technical and economic feasibility of integrating geoDHC in their area, such as guidelines on the Knowledge Base, available datasets and tools, strategies and best-practice example of how geothermal energy can help decarbonize H&C.

3) Researchers and academia
A researcher wants to develop further research on geoDHC in the EU and looks for available knowledge, data, and tools.

The researcher finds the SAPHEA MUH & Gamebook CYOA.

The researcher navigates the gamebook.

The researcher discoverers useful resources for early-stage geoDHC investment decision support and strategic planning on the SAPHEA MUH that she/he could use to advance her/her research, such as guidelines on the Knowledge Base, available datasets

and tools, strategies and best-practice examples of how geothermal energy can help decarbonize H&C.

4) policymakers national/EU

A national/EU policymaker needs to develop informed and science-based policies to support further adoption of geothermal energy and geoDHC.

The national/EU policymaker looks for available knowledge and guidelines and comes across SAPHEA MUH & Gamebook CYOA.

The national/EU policymaker navigates the gamebook.

She/he discoverers useful resources for early-stage geoDHC investment decision support and strategic planning on the SAPHEA MUH, to develop informed and science-based policies to support further adoption of geothermal energy and geoDHC such as guidelines on the Knowledge Base, available datasets and tools, strategies and best-practice example of how geothermal energy can help decarbonize H&C.

5) civil society & lay public

Any other interested stakeholder wants to learn more about geothermal energy.

The interested stakeholder looks for user-friendly guidelines to understand more about geothermal energy and geoDHC and comes across SAPHEA MUH & Gamebook CYOA.
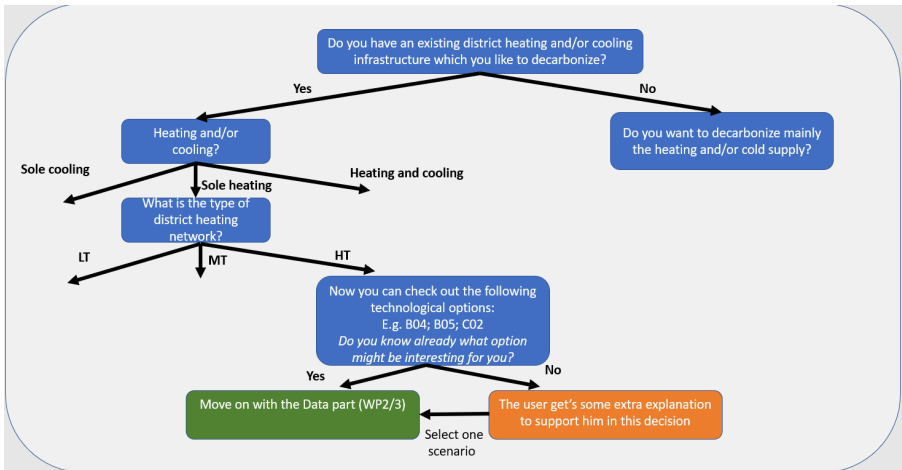
The interested stakeholder navigates the gamebook.

She/he discoverers useful resources for early-stage geoDHC investment decision support and strategic planning on the SAPHEA MUH such as guidelines on the Knowledge Base, available datasets and tools, strategies and best-practice examples of how geothermal energy can help decarbonize H&C.

All these resources are not provided all together, but through a series of questions, and are linked based on a series of questions: XXX.

| | |
|---|---|
| **Situation.** The scenario where the scene takes place. | Situation — When and how does the issue manifest? In which circumstances does it appear? When does it manifest? How often? How does it manifest? What happens? What are the risks? Who is there? What do they do? What do they do wrong that causes the issue? |
| **Task.** The particular issue to solve. | Task — What is required to do to solve the issue, and what are possible alternatives? What do you think you need to do to fix the problem? How do you cope with the issue? What is challenging in solving the problem? How do you analyze the situation? |
| **Action.** Optimal decisions, as well as less effective choices | Action — What do you actually do to solve the issue? What a possible solution might be? Are there other solutions? Can you list all the possible solutions? What are the alternatives? Can you list something people mistakenly tend to do, which does not solve the problem? |
| **Result:** What happens as the result of the actions (problem solved/further issues) | Result — What are the consequences of the undertaken action(s)? What results as a consequence of your chosen action What the consequences would be if you were taking some alternative actions? Considering the outcomes, what is the best and worst thing to do? |
| **References** | |

| STAR FORM | |
|---|---|
| **Deliverable** | **D2.2 – Scenario catalogue** |
| **Situation.** The scenario where the scene takes place. | ● You might want to look into geothermal heating and cooling, but you don't have any specific idea yet what type of technological options are suitable for your setting<br>**E.g. for the question about the "Assessment of the network's technical constraints" on the second page of your second slide**<br>**Maybe we also need a simple first version in the "network technical constraints" on page 1** |
| **Task.** The particular issue to solve. | ● Identify a potential interesting technological option for your case ▯ Assess in the follow-up questions, if you have a promising geothermal potential (or at least the potential to assess it) |
| **Action.** Optimal decisions, as well as less effective choices |  |
| **Result:** What happens as the result of the actions (problem solved/further issues) | ● Move on to the Choice of the scenario in combination with the evaluation of the available/needed data. |

| STAR FORM | |
|---|---|
| **Deliverable** | **D2.3 – Catalogue of spatial datasets including data preparation guidelines and protocols** |
| **Situation.** The scenario where the scene takes place. | ● Needs of knowledge about the existence of restricted areas |
| **Task.** The particular issue to solve. | ● Existence of restricted areas datasets or not |
| **Action.** Optimal decisions, as well as less effective choices | ● The user is linked to the desired dataset.<br>● The user is linked to the catalogue of datasets for self-search. |
| **Result:** What happens as the result of the actions (problem solved/further issues) | ● User will have access to the dataset |

| STAR FORM | |
|---|---|
| **Deliverable** | **5.2 – Status report on the socio-environmental conditions for the implementation of geoHC networks in Europe** |
| **Situation.** The scenario where the scene takes place. | • A Mayor would like to integrate geothermal energy into the district heating and cooling (DHC) grid of its city |
| **Task.** The particular issue to solve. | • Economical aspects: get financing to realize the geothermal power station<br>• Social aspects: gain the confidence of final users<br>• detailed evaluation of eventual environmental aspects based on the specific geographical area in which the thermal power plant is planned to be realized. Based on this, it is also important to evaluate a possible technology (taking an example from the scenario catalogue such as D 2.2) |
| **Action.** Optimal decisions, as well as less effective choices | • Evaluating the thermal potential of the area based on the real energy needs for space heating and cooling of the city, using specific tools which allow for briefly evaluating the environmental, technical, and economical aspects. This is a tool to preliminarily evaluate the main characteristics, before a detailed feasibility study.<br>• Submitting a project proposal to obtain local and/or European funding to economically sustain the project.<br>• Involving financial stakeholders, possibly interested in investing in specific projects<br>• Creating (or using, if already existing) a business model to be adapted to the specific project<br>• Organizing dissemination events for the general public to increase trust in this kind of project, or other kinds of activity also in the form of game book |
| **Result:** What happens as the result of the actions (problem solved/further issues) | • Asking consultants aimed at doing a specific feasibility study which definitively evaluates technical, social, and economic features of the planned project.<br>• Taking a more conscious decision, correctly sizing the geothermal plant useful to feed the DHC grid and taking into account all social needs |

| STAR FORM | |
|---|---|
| **Deliverable** | **5.2 – Status report on the socio-environmental conditions for the implementation of geoDHC networks in Europe** |
| **Situation.** The scenario where the scene takes place. | ● A mayor wants to implement a DH grid |
| **Task.** The particular issue to solve. | ● Is geothermal energy socio-economic-environmentally sustainable in his city compared to conventional systems? |
| **Action.** Optimal decisions, as well as less effective choices | ● Use the "SEES evaluation worksheet" from D5.2 |
| **Result:** What happens as the result of the actions (problem solved/further issues) | ● The result of the calculation says if geothermal is socio-economical-environmentally sustainable in his city |

| STAR FORM | | |
|---|---|---|
| **Deliverable** | | **5.2 – Status report on the socio-environmental conditions for the implementation of geoDHC networks in Europe** |
| **Situation.** The scenario where the scene takes place. | | • A mayor wants to integrate a specific geothermal technology into the existing (or planned) DH grid |
| **Task.** The particular issue to solve. | | • Which geothermal scenario is the best in terms of socio-economic-environmental sustainability in his city? |
| **Action.** Optimal decisions, as well as less effective choices | | • Use the "SEES evaluation worksheet" from D5.2 |
| **Result:** What happens as the result of the actions (problem solved/further issues) | | • The result of the calculation says which one of the scenarios has the best socio-economic-environmental sustainability. |

| STAR FORM | |
|---|---|
| **Deliverable** | 5.3 |
| **Situation.** The scenario where the scene takes place. | Engaging stakeholders |
| **Task.** The particular issue to solve. | How to engage stakeholders efficiently? |
| **Action.** Optimal decisions, as well as less effective choices | 1) Host public consultations and informational campaigns. <br><br> 2) Focus primarily on technical and financial stakeholders. |
| **Result:** What happens as the result of the actions (problem solved/further issues) | 1) Community support strengthens. Concerns are addressed upfront, reducing future resistance. <br><br> 2) The community feels excluded, leading to possible resistance and delays. |

| STAR FORM | |
|---|---|
| **Deliverable** | 5.3 |
| **Situation.** The scenario where the scene takes place. | Developing the project |
| **Task.** The particular issue to solve. | How to efficiently and correctly implement the project? |
| **Action.** Optimal decisions, as well as less effective choices | 1. Implement a Life Cycle Assessment (LCA) to evaluate environmental, economic, and social impacts. <br><br> 2. Expedite development with minimal impact analysis. |
| **Result:** What happens as the result of the actions (problem solved/further issues) | 1. Ensure long-term sustainability, meet climate goals, and strengthen funding applications. <br><br> 2. Risk of future environmental and social issues. Initial costs may rise due to unexpected challenges. |

| STAR FORM | |
|---|---|
| **Deliverable** | **5.3** |
| **Situation.** The scenario where the scene takes place. | Regulatory streamlining |
| **Task.** The particular issue to solve. | How to address the regulatory framework for developing a geoDH? |
| **Action.** Optimal decisions, as well as less effective choices | 3. Advocate for a simplified permitting process<br><br>4. Leave the permitting process as it is currently |
| **Result:** What happens as the result of the actions (problem solved/further issues) | 3. Reduces delays but requires significant political effort.<br><br>4. Depending on national legislation, the process can be very long. Delays could be expected and investors could brefrainto pursue this project. |

| STAR FORM | |
|---|---|
| **Deliverable** | **Linked In Group "Geothermal District Heating and Cooling"** |
| **Situation.** The scenario where the scene takes place. | ● The protagonist is an engineer in the field of District heating and cooling, but not for geothermal; OR<br>● An expert in geothermal but not for District Heating |
| **Task.** The particular issue to solve. | ● He/she wants to get in touch with a network of experts bringing together both disciplines |
| **Action.** Optimal decisions, as well as less effective choices | 1. Create a LinkedIn account and connect to the Experts group: https://www.linkedin.com/groups/9508341/ |
| **Result:** What happens as the result of the actions (problem solved/further issues) | ● Start discussion and networking with experts, |