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Games and gamers: the influence of participating players on the process and outcome of regional spatial energy games

Hartmut Dumke[1*] and Pia Nabielek[2]

Abstract

Background One major question of climate and energy policy is how to act under conditions of great uncertainty. This contribution relates to the literature that studies how various actors draft regional energy scenarios and pathways in so-called serious games. Serious gaming aims to foster contextual knowledge generation about complex problems and spatial solutions associated with sustainability transitions.

Little attention has thus far been paid to the question of how to design a serious game that enables desired game results through different player constellations. Shortcomings in the literature regarding the inclusion of relevant players and secure game experience through player interaction are covered by stakeholder theory. Our approach assigns different attributes to individual players which secures that the game is played from various perspectives and by actual stakeholders.

Results and conclusions Our empirical study shows the impact of players with different stakeholder attributes on two game results: the first game result is a spatial energy scenario (output) and the second result is the collective and place-based learning experience during the game (outcome). The paper closes with three concluding recommendations:

- It is important to pay attention to player's attributes as well as to constellations of players since they influence game experience (outcome) and achieved scenario (output).
- Player's attributes and constellations can partly explain differences in game results, but more empirical work on the influence of players and games on the results is necessary. In the future, more attention should be paid to the interaction, discussions and dynamics within the player teams.
- The optimization of player teams needs to be strongly considered in game design. Also, we note that if the game is played in a regional context, the spatial orientation (the region) could be taken into greater account when applying stakeholder theory.

Keywords Energy transition, Regional planning, Serious games, Stakeholder theory

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Background

Serious games in the energy context

In climate and energy policy, official projections of energy futures are usually quite abstract, with quantitative benchmarks taking centre stage. The calculation techniques that are used to create these scenarios need an extensive simplification of the spatial and socio-political environment in which energy is produced, distributed and consumed [1, 2]. A dominant paradigm is, for example, to generalize various forms of renewable energy generation and express the potential contribution of these sources as 'oil-equivalent'. In doing so, the political goal is highlighted to overcome reliance on fossil fuels [3]. These abstractions however run the risk of stripping energy of the dynamic, social processes at different levels of implementation [4].

With the 2016 Paris Agreement [5], this framing has profoundly changed. Since then, the course in global climate politics has been set towards more implementation-oriented policies [6]. This, again, has largely impacted the ways how analysts look at, and study, climate and energy-related future prospects. It required the development of an analytical vocabulary that drives on actors, politics and governance rather than on standardized matrices and the outlining of targets at a governance level far from implementation settings [3]. What these conceptualizations roughly have in common is that they emphasize the importance of place-based knowledge generation and, subsequently, governance practices that support exchange of views, experimentation and innovation [1]. These governance practices entail learning processes that are searching by character rather than straightforward and strategic. To the extreme, based on this newer perspective, there is no prescribed path to a sustainable energy system, instead there must be 'room for reflection' about dominant procedures that might prevent the establishment of innovative ones [7, 8].

To give the perspective of learning processes an empirical focus, we specify 'place-based knowledge generation' as the protected environments where actors with various backgrounds collaboratively develop future sustainability pathways for a specific place or region, such as suggested by Hajer and Pelzer [6]. One acknowledged instrument to furnish these environments are serious games and other kinds of planning support systems [9–11]. Serious games are usually applied by selected groups of actors and simulate 'real-situation' discussions and conflicts. Design, comprehensibility and setting are deemed important influencing factors for the usability of gaming techniques and, subsequently, discourse quality and learning [12–14].

Previous contributions have studied knowledge generation in game situations from the perspective of game-performance rather than from the logics of user-interaction. We argue that while much attention has been paid to games (tools, layout, setting), rather little attention so far has been paid to the players. If serious gaming refers to an activity through which actors come to share particular orientations for action [12, 15–17], the quality of the game (as simulating a real-world discussion about future prospects) is clearly not only an instrumental question but also one of 'users'. In other words, the kind of knowledge that is gained is largely dependent on those who take part in the game: their interests, competencies and capacity to make own choices [6]. Although studies propose that serious games in the energy context should be designed in an inclusive way [18, 19], little is known about the criteria that make a good player and a well-balanced discussion when dealing with the different 'voices' concerning energy and climate futures.

The purpose of this paper is thus to approach the role of players more systematically. The question we address is: How to design a serious game that enables desired game results through different player constellations? To answer this question, we consult serious game literature and stakeholder theory to construct our approach to classify relevant players. We present empirical results of a regional cardboard game developed by Dumke et al. [20]. Since its first application in Rankweil, Austria, the game has been applied in 3 different regions and over 20 game rounds, and with different players and group compositions, hereby providing a rich set of data for our research question. Before presenting our empirical work, where we focus on 4 game rounds from the same region, the next section will argue why an analytical basis is needed to identify and categorise game users. Actor's considerations in sustainability transition literature and insights from stakeholder theory will be incorporated into a proposed perspective for the empirical part of the paper.

Theoretical background: serious game design and stakeholder theory

Gaming refers to the activity of actors to playfully explore possible manoeuvres within a particular set of rules and according to specific interests and positions [13]. Games that are primarily designed for educational purposes are often referred to as serious games. The attribute of seriousness relates to the learning processes and outcomes the game would support [21]. Even if serious gaming is supposed to be entertaining—such as any other game—the deeper purpose and goal is to foster knowledge generation among particular sets of actors and linked to particular problems or places. In the energy transition context, games are means to understand more about complex matters [18].

If understanding complex matters is the prospect of a serious game, games must be optimized to achieve serious outcomes [9]. Winn [9] lists three interrelated components to optimize a serious game:

- The *design* part, or the proposed setting and content of the game, including the rules how to play and win the game, and desired game results. This part is shaped by the game designer.

- The *play* part, which involves the choices a player makes and the lessons learnt, including lessons and choices that arise from the dynamics of a team. This part is the player's part.
- The *experience* part, or the main prospects of the game, such as instructive, affective or aesthetic prospects. This part is the result of both designing and playing.

If we relate Winn's logic of 'design, play and experience' to common expectations in the literature on serious games in the energy transition context, three possibilities to improve serious games come into play: on the design part, a safe setting is relevant to stimulate experimentation. Serious games are artificial environments where experimental learning is activated through gameful (rule-based) and playful (free-form) activities [11, 13, 22–25]. According to sustainable transition scholars, energy transition (or any transition) is a societal movement—characterized by *"multi-actor processes, which entail interactions between social groups"* [26]. Actors-in-interaction need support in actively re-thinking the structurally embedded logics that normally govern their practices [8]. Serious games are support tools that allow actors to explore more radical innovation trajectories and formulate alternative goals and agendas [27]. At the same time, a serious game provides opportunities for actors to safely explore what could be the possible pitfalls of place-based solutions. Players may try alternative paths without facing the consequences as it would be in real-life situations. This function is particularly useful for visioning, scenario-building, and back-casting approaches in the energy context, where actors involved would test their strategies and compare their impacts [12]. Especially serious games in the energy/spatial planning nexus do not necessarily aim for one optimized future, but for multiple pathways while paying close attention to various actor's perspectives of how to get there [28, 29].

On the play part, optimizing the game concerns the background a player, or a team of players, would bring into the game. Scholars describe games as 'techniques' that bring various actors (with various perspectives and skills) together around possible futures with the purpose to identify shared/collective orientations of action [6, 12, 15–17]. Game-participants get the opportunity to learn about less familiar solutions, through the concerns of their fellow players. Games enable players to reflect on the preferred solutions of other actors [14, 23, 24, 30]. In order to achieve this kind of reflection, however, studies in the field of energy and social practice warn that more attention must be paid to the background of the players. There is a danger to overlooking important players. "Partly because large-scale technological examples command so much attention, commentators take it for granted that policy and corporate actors are key players, even if the necessary involvement of other groups and interests, including those of 'users' is repeatedly acknowledged" [31]. The energy transition process is embedded in a complex stakeholder network [18], yet there is an overall tendency to play serious games in 'expert' settings (elitist perspective) [25].

On the experience part, fun and teaching is at the heart of any serious game. In this context, tangible game results, for example a visualization or future scenario, is not only more fun but more instructive. It helps the player to "dive" into three perspectives:

- Protected environments that stimulate experimentation.
- Instruments that foster interdisciplinary learning.
- Practices or 'techniques' that enable collaborative action.

The first and second perspective focus on cognitive benefits of gaming. Serious games are artificial environments where experimental learning is activated through gameful (rule-based) and playful (free-form) activities [11, 13, 22–25]. They are support tools that enable players to reflect on the perspectives/preferred solutions of other actors [14, 23, 24, 30].The third perspective—games as 'practices'—suggests behavioural benefits. In addition, game experience is strongly linked to the game's dynamics (the play part) [9].The optimization of the game dynamics is intended to promote the player's interaction with the game and during the game.

We conclude that players are at the core of game optimization and need to be strongly considered. The suggestion to involve 'differentiated views' in serious games has been made before and has been tested [13, 18]. Not only professionals and innovative newcomers, but virtually anyone can be affected by energy futures and therefore be ready to act for their purposes. But if scholars warn of limited sets of players, which kind of players and which backgrounds are then important to consider in design, play and experience? Which interests and capacities have to be present in stimulated game situations to provide desired and serious game results? These questions are addressed in the next section.

Insights from stakeholder theory

What remains the central challenge from the perspective of serious gaming is to identify relevant actors according to a specific situation; and to assign various attributes to the individual player. This is where stakeholder theory provides a helpful and heuristic analytical base since it offers conceptualizations to identify parties who have strong claims in general terms, while permitting the 'explicit recognition of situational uniqueness' [32].

Stakeholder theory is rooted in the field of organization management and offers conceptualizations to identify groups that are affected by companies (or other types of organizations) and their relations. These might be an organization's employees and financial shareholders, but also wider circles of actors such as local communities, creditors, politicians or suppliers. Moreover, relations between the organization and its stakeholders are not limited to rational or financial motives, there are also moral and even philosophical guidelines [33]. In fact, stakeholders are *"any group or individual who can affect or is affected by the achievement of the organization's objectives* " [34].

According to scholars of stakeholder theory, stakeholders must have serious claims to get actively involved in an organization's objectives. Mitchell et al. [32] have developed a normative theory of stakeholder identification and salience based on three core-attributes: *power*, *legitimacy* and *urgency*. These three variables define a broad field of potential or actual stakeholders so that no groups or individuals are excluded from analysis a priori, also those that have moral rather than material claims [ibid, p. 854].

The attribute of *power* describes the ability of a stakeholder to impose its will in an organizational setting or relationship. Powerful stakeholders "have or can get access to coercive, utilitarian, or normative means" [ibid, p. 865], depending on the type of resources they have to exercise power. We note that in the energy context, powerful resources often refer to utilitarian aspects such as material and financial resources and normative means, e.g. public organizations that own or co-own energy facilities. In addition, studies identify energy grid operators and renewable energy suppliers as powerful stakeholders [18, 19].

The second attribute, *legitimacy*, is more difficult to operationalize. It represents distinct relationships with the organization's objectives. These objectives, in the context of energy, might be interpreted in various ways. One objective could be the formalized climate goal of a state, region or municipality. Relevant stakeholders might be politicians that are heavily interested in the fulfilment of election promises. Other objectives might be more related to considerations of social justice, such as the aim to actively involve citizens in decision-making. Relevant stakeholders have the authority to decide on behalf of others, or make decisions about them. Examples of such stakeholders are housing corporations [19]. A relationship is then legitimate when it refers any kind of voluntary acceptance of authority based on considerations of public interest [35]. The logic of appropriateness [36] might involve stakeholders driven by their consideration for the behalf of 'others'.

Urgency is the third attribute and relates to relationships marked by circumstances under which 'time will be of the essence" [32]. This attribute brings the element of dynamism into stakeholder identification and salience since the urgency relationship only exists when a claim is of time-sensitive nature and important/critical to a stakeholder [ibid, pp. 867–868]. Some of these claims can strongly be recognized in governmental and non-governmental organizations representing environmental and other collective interests, and are mobilizing the public against established and unsustainable practices and procedures. Examples of such stakeholders are citizens initiatives and environmental organizations [18].

More principles to classify stakeholders result from the combination of power, legitimacy and urgency. According to Mitchell et al. [32], stakeholders may have one, two or three of these attributes. The more attributes stakeholders possess, the more 'salient' they are. Low salience classes (one attribute) are 'latent stakeholders' because they are not likely to give much attention or special acknowledgement. These are, for example, stakeholders who own attributes of power but do not have any legitimate relationship or urgent claim to exercise power. In the context of a serious gaming, such a stakeholder might be a mediator, or an invited expert, who has no actual relation with the specific region and energy future that is at 'stake'. Stakeholder salience increases when more than one attribute is present. When two attributes are present—legitimacy & power, legitimacy & urgency or power & urgency—stakeholders may be called 'expectant' because they will act according to certain expectations. In practice, these stakeholders are expected to have a serious interest in energy transition. In this category, stakeholders such as non-governmental environmental organizations, renewable energy lobbyists, citizen movements, innovative companies and knowledge institutions might be particularly important. Expectant stakeholders might act dominant (legitimacy & power), might feel dependent and act through advocacy and guardianship (legitimacy & urgency), or might even act ruthless (power & urgency). The combination of all three attributes are the defining features of a highly salient stakeholder. In the context of a serious game played in a particular region, these highly salient stakeholders might have a high degree of power, represent regional actors' interests and are actively lobbying for sustainable energy futures.

Figure 1 (below) shows the attribute classes from Mitchell's stakeholder theory. By adding, in red letters, we have roughly positioned stakeholders that might be present in serious games which focus on energy topics.

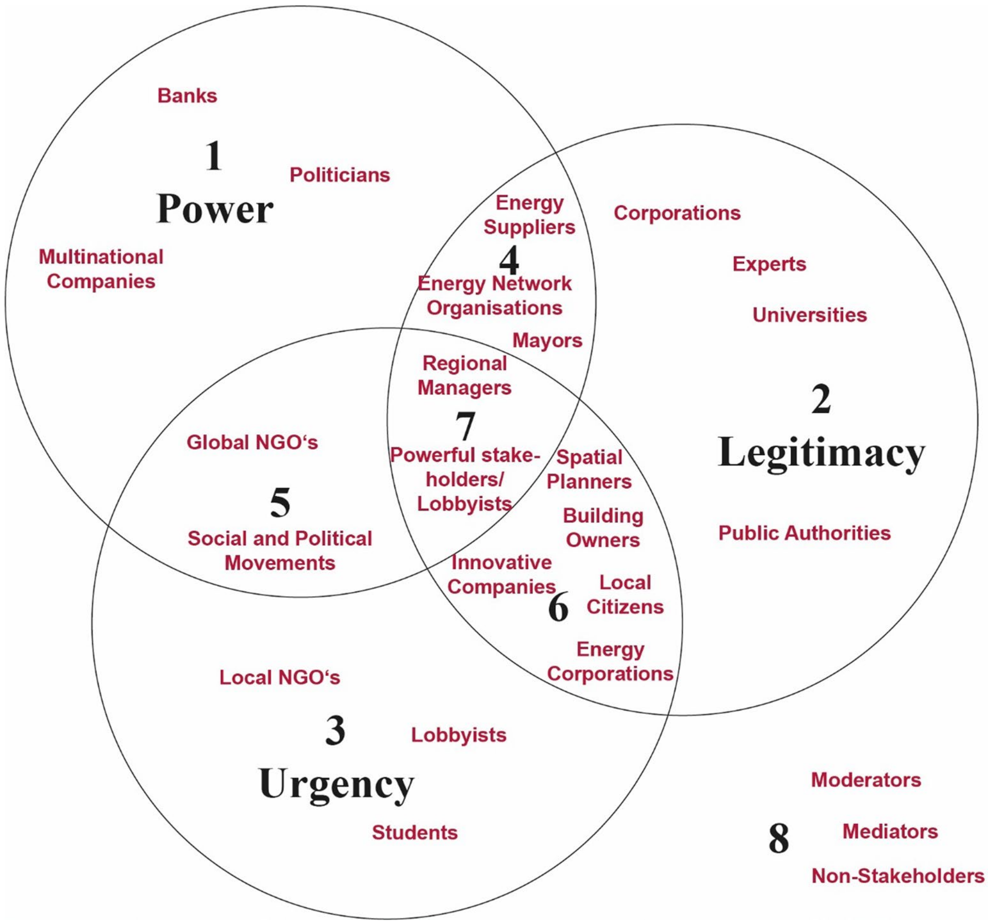


Fig. 1 Mapping potential energy transition actors in the Mitchell et al. (1997) scheme of stakeholder classification and salience. 1 Stakeholders who have powerful means to impose their will on others. 2 Stakeholders who are authorized to act on behalf of others. 3 Stakeholders who have the urge to act immediately. 4 Powerful stakeholders representing public interests related to energy. 5 Powerful stakeholders lobbying for their own climate/energy concerns. 6 Stakeholders who represent the pressing concerns of actors affected by energy politics. 7 Powerful stakeholders who are actively lobbying for regional interests and energy/climate concerns. 8 Non-stakeholder or moderator. Source: adapted from Mitchell [32]

Although our mapping exercise is purely indicative and does not relate to the whole spectrum of energy transition actors (we have only mapped a selection of actors that are present in our empirical study). We conclude that the Mitchell et al. [32] scheme of stakeholder classification and salience is valuable for our quest here, which is to understand how games can be optimized through player's constellations. We will put the scheme into operation in Sect. "Results", in combination with a serious game designed according to Winn's principles of design, play and experience framework [9]. The next chapter describes how we designed our game along Winn's framework, we here describe the system of results, methods and metrics that the explain the different results.

Method: developing, executing and evaluating a serious (energy) game

The design, play and experience framework: our game features

Our specific game design was inspired by the Design, Play and Experience (DPE) framework of Winn [9]. The main elements are:

- The overall goal of the game is to explore a spatial scenario for up to 100% renewable energy supply (thermal and electrical energy, with the exclusion of energy demands for mobility)
- The guiding narrative is to achieve an annual equilibrium between the annual energy demand and energy generation from renewable resources. Calculations of

energy demand in gigawatt hours per year (GWh/y) predefine the game setup on a scoreboard. Energy distribution aspects such as short-term fluctuations between supply and demand or network capacities are very important in practice but were to be ignored in the game.

- Players have to locate renewable energy potentials on the regional map until the total energy demand is covered. Area requirements are directly displayed (by the use of 'pins') for each renewable energy source and per energy yield/year (watt hours per square meter and year, Wh/m^2.y). The areas units for the renewable energy potentials are mobile and ready-to-use, and can be pinned on the map, which serves as the interface between the status quo and the future scenario. The use of energy potentials in protected areas was not forbidden, but players could decide whether they wanted to do so or not.
- The game's progression is straightforward. A team of up to eight players can complete the energy scenario in approximately 45 min. The game setup is easily repeatable, regardless of the physical setting or location. This allows for a reasonable degree of comparability between results and enables players to readily explore the spatial impact of a regional energy scenario in accordance with the anticipated experience.
- There is no competition between the player teams—but after the game rounds, there are debriefing comparisons between the scenario results, which provides interesting insights among the teams. Those insights are also part of the anticipated group experience.

Context of the game

In the context of the research project 'ERP_hoch3' [12, 20] a serious game has been designed and applied. ERP_hoch3 is the abbreviation for 'integrated spatial and energy planning for smart urban quarters and regions' and took place 2015—2017 in cooperation between the Technical Universities of Vienna and Graz in Austria. This research project focussed on three main topics: energy scenarios on an inter-municipal level, the energy development of urban neighbourhoods and around public transport hubs. The initial plan was to create the inter-municipal energy scenarios using purely quantitative models of geographical information systems, but it quickly became apparent that the data available for this were completely inadequate. For this reason, the decision was made to develop a serious game instead, which not only visualizes regional energy scenarios, but also allows the difficult negotiation processes of the participating stakeholders to be observed and evaluated.

Design of the game

The game is played on a large cardboard featuring a topographic base map of the case study region in the scale of 1:50,000. This base had open street map origins, showing typical situation content like settlements, roads, buildings, forests, etc., and some relief shading. To display some administrational and territorial context, municipality borders and other territorially defined areas (e.g. protected natural areas) were added to the map.

The second important game items are the 'pins', which are presented in the map-legend of the cardboard. Pins stand for renewable energy potentials and solutions, including spatial demand (represented by pins of different sizes) and the energy yield per year (represented by energy dots). One pin set features electricity potential areas, the other set heat potential areas. In Fig. 2 below you can find explanations on the renewable energy units, as well as on their "yield value" both in Wh per m2 and year, but also in normalized "energy dots" (one energy dot represents 0,5 GWh/y).

The third item used by ERP_hoch3 players is the 'scoreboard', visualized by a bar graph of 'energy dots' on the cardboard where the players, during the game rounds, would record the amount of energy (GWh/y) of the 'pins' they have placed on the regional map, by striking out the corresponding amount of energy dots. The best possible "100% result" would be to match all heat and electricity energy demands from renewables, which, in the Vorderland-Feldkirch case, would be additional 476 GWh/y thermal energy and 34.7 GWh/y electrical energy. "Additional" means that the already realized renewable energy generation was estimated and subtracted from the remaining game task to achieve a "100% renewable scenario", or an annual equilibrium between the renewal energy generation and the energy demand. The layout, goals and equipment (scoreboard, pins) of the game, as described above, always remained the same. This is a particularly important pre-condition to judge the influence of the players constellations, each resulting in different scenario's and learning experiences.

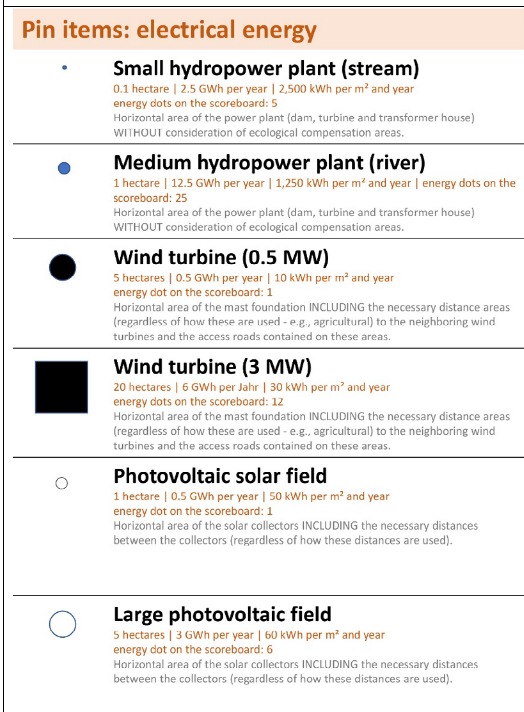
Figure 2 (with legend translations) shows what players use when applying the ERP_hoch3 game.

In addition to the game explanations, Table 1 below summarizes spatial and demographic features of the game region.

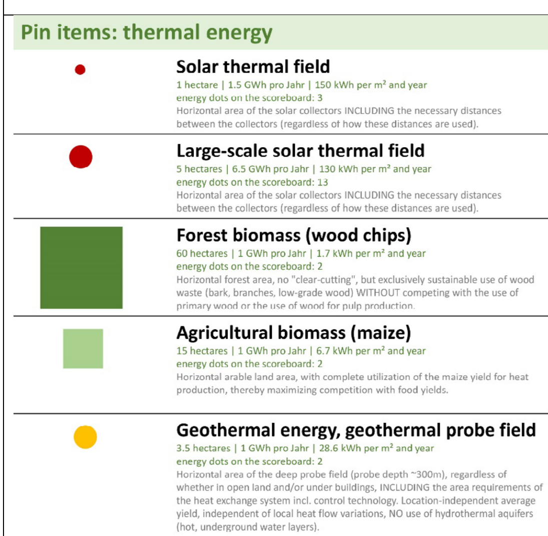
Methods and metrics of the result generation

Since its first implementation in the Vorderland-Feldkirch Region (in the federal state of Vorarlberg, nest to Germany and Switzerland) in 2016, the ERP_hoch3 game has been deployed throughout Austria. Subsequently, a second base map was created in 2018 for the adaptation

Overview: A photo from one of the game rounds, showing the map, the legend, the pin items and the scoreboard

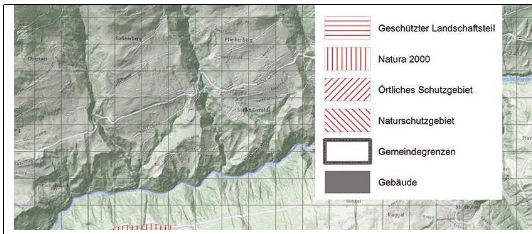


The pin items for the potentials from electrical energy: 2 types of hydropower, two types of wind turbines, 2 types of photovoltaic power plants. Energy yield values per pin, given in absolute and relative numbers (GWh/y and $kWh/m^2.y$) and as number of energy dots on the scoreboard

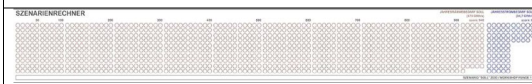


The pin items for the potentials from thermal energy: 2 types of solar thermal heat, two types of biomasses, 1 type of geothermal heat. Energy yield values per pin, given in absolute and relative numbers (GWh/y and $kWh/m^2.y$) and as number of energy dots on the scoreboard

Fig. 2 Map gameboard, Legend, pin items and "energy scoreboard" from the "ERP_hoch3" game. Source: [20]



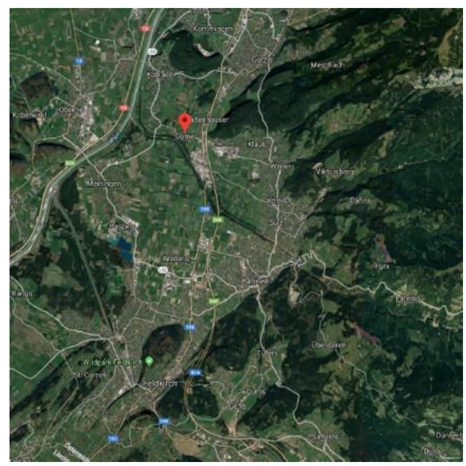
- protected part of the landscape
- NATURA 2000 areas
- local protected area
- nature reserve
- municipal borders
- buildings



The scoreboard, where the ‚energy dots' from the pin items are logged.

Fig. 2 continued

Table 1 Regional features of the "ERP_hoch3" game region. Source: own editing, satellite maps: [37]

Region	Region "Vorderland-Feldkirch" Vorarlberg, west Austria, close to the border of Switzerland and Germany	Satellite photo
Coordinates (regional centre)	47.2810608, 9.5679832	
Population (2016)	65,027	
Population density (cap/km^2)	365	
Area (km^2)	178	
Regional spatial features	85% of the population live in a rather industrialized, densely populated agglomeration along the flats of the Rhine river, the other 15% in rather rural, alpine municipalities. In Austria, the Rhine Valley is one of the most industrialized and densely populated regions	

of the game in the Waldviertel Ost Energy Region in Lower Austria, and a third version was developed in Styria (this time using a digital, MS Excel-based scoreboard). However, in order to respond adequately to the research question posed in this paper, we will limit our comparison to the results of four game rounds from the Vorderland-Feldkirch Region.

Before we show and compare the results, we would like to briefly describe our method of participation and observation. Our method of playing the game belongs to the so-called "participant observation" [38] from qualitative social research. Members of the research team had the role of a mediator, which included a thorough introduction, controlling the time limit, but also actively intervening when conflicts or spatial barriers delayed result generation of the game became apparent. Also, we answered energy-specific details that occurred during the game (Tables 2, 3).

In the gradation between rather passive and very active participation, on a scale from 1 to 5, our role can therefore be classified as 3 which stands for "moderate participation" [38]. Our role also included taking notes of player quotes and (after the end of a round) moderating a reflection on the results of a single game, or (if there were several rounds with several groups in succession) the moderated comparison between these different results. The following

Table 2 System of results, methods, metrics

Result	Method	Metric
Renewable energy scenario: share of renewable energy	Playing the game, then counting the energy dots as overall score	Quantitative, %, up to 100%
Group constellation	Grouping the players in mixed groups according to Mitchells' stakeholder classes	Quantitative, number of players per class, share of local players in one group (x out of a maximum of 8)
Mood during the game (game experience related to individual and common prospects)	Participant observation, debriefing with players and mediators	Qualitative, optimistic–pessimistic-mixed
The experience part, or the main prospects of the game, such as instructive, affective or aesthetic prospects. This part is the result of both designing and playing	Participant observation, debriefing with players and mediators	Qualitative, text quote on the experience. The quote is representative of the mood during the game

Table 3 Results overview

Result	Group #1	Group #2	Group #3	Group #4
Renewable energy scenario: share of renewable energy	30%	100%	80%	75%
Share of local players	3/6	2/5	0/5	0/5
Mood during the game	Pessimistic	Mixed	Optimistic	Optimistic
Quote on common learning experience	"We have to do something!"	"It's clearly a regional task!"	"A lot of progress is possible!"	"Regional gaming makes sense!"

table shows results, methods and metrics that we used during and after the game rounds. Along this System, the next chapter shows all results in detail. Further details regarding the group constellations can also be found in the appendix.

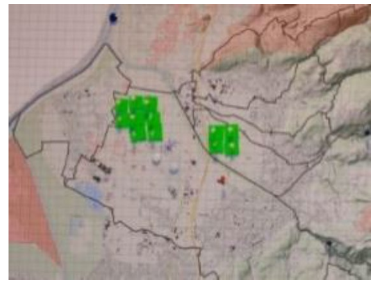
Results

The following results section has two parts: in the first part, we briefly list the results. In the second part, we give interpretations how these constellations influenced results and learning experiences. The latter is a central result that answers the main research question of this paper: how do different constellations of players influence the results of serious games?

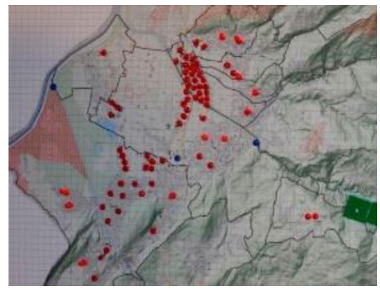
Overview

Interpretations of the relationship between player constellations, spatial strategies and results

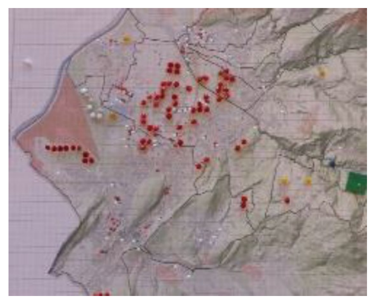
Group #1. The spatial location of each pin was only determined after a long discussion process and with the utmost caution, which was caused by the fact that the participants had an extremely precise local knowledge of all possible environmental impairments in the entire game region. Due to this caution, in the scenario map no large clusters of potential emerged spatially, only isolated, small ensembles. The game example on the right shows two maize potentials in light green and individual, non-clustered photovoltaic potentials (small and large white pins). Reflection after the game revealed an overall mood that was more pessimistic than the result: although it was agreed that the energy transition must achieve results faster than before, these implementations are always delayed by justified or unjustified concerns and protests from citizens



Group #2 Spatially, the potentials were located quickly and without long discussions, also because the group shared a very technical-pragmatic basic attitude. In contrast to the first group, group 2 had significantly less local knowledge, which is why there were very few inhibitions about placing large, contiguous potential clusters. The map result example on the right shows huge solar thermal clusters (in red) directly on the outskirts of the town. Despite the "optimal result", reflection after the game revealed a pessimistic mood: although the players consider themselves to be competent in matters relating to the energy transition, they do not consider themselves to be legitimized and powerful enough to implement regional energy scenarios and also, they were very sceptical against the simplifications of the game (see Chapters **3**)



Group #3 After an initially slow start when setting the first potentials, the speed of the results quickly increased. In contrast to groups 1 and 2, the reflection after the game showed a much more optimistic basic attitude, since the players considered themselves able to make a positive change in regional energy scenarios. Spatially, this attitude was reflected in a mix of both small-scale and large-scale potential localizations—in the map example on the right, you can again see the large-scale solar thermal potentials (in red), but accompanied by many considerably smaller solar thermal and geothermal potentials (in white and yellow, respectively)



Group #4 Similarly to group 3, after an initially slow start when setting the first potentials, the speed of the results increased quickly. In contrast to groups 1 and 2, the reflection after the game showed a much more optimistic basic attitude, similar to group 3. Spatially, this attitude was reflected in a mix of both small-scale and large-scale potential localizations—but the group was the only one to also locate large potentials for wind power (black squares) and forest woodchips (dark green squares), and unlike all other groups, it also located these potentials much further away from the edges of settlements

When comparing the 4-group constellation with specific scenario results, two kinds of constellations can be identified:

- The first group, consisting mainly of local/regional actors, who represent ‘expectant’ or even highly salient stakeholders, clearly judged the spatial compatibility of renewable energy solutions more importantly than the unconditional achievement of a 100% renewable target. Their precise knowledge of the case study region obviously led to a great deal of caution, in making decisions at individual sites, ending up with only about a ~ 30% game achievement rate.
- In contrast, the second set of groups (groups 2 to 4) consisting mainly of external experts took more bold and adventurous moves as they went for the game-goal of “100% renewable energy” and generic approaches in strategies or spatial patterns, for example “filling-up spaces next to mobility infrastructure”. Such groups tend to take a more technical and pragmatic approach, ending up with 100% (or close to 100%) game achievement rates.

Thus, our empirical results show that there might be some relation between gamer’s attributes, group constellations and game results. Though differences can be interpreted in dialogue quality, learning still seems to be rather idiosyncratic, relating to individuals, rather than group reflection and experience. What can be discerned from the collected data, is that mediators were vital in the search for collective interests and an inclusive dialogue that respects a diversity of perspectives. There are two possible explanations:

- First, mediators, though classified as non-stakeholders, might still take on the role of a stakeholder when participating in the game.
- Secondly, mediators might have played a crucial role in facilitating the dialogue between the other players.

Discussion and conclusions

Approaching from the Design, Play and Experience framework, the results of our regional energy game show that player constellations should be taken more seriously, when the prospect of the game is to achieve serious results such as knowledge generation about complex energy problems. Our approach to classify relevant players does justice to the broad stakeholder network that is involved in energy transition and is offering a systematic way to include the skills, preferences and mindsets of a player in the game design. The step from an individual player's attributes to player's constellation however deserves more attention. We conclude that both individual gamer's mindsets as well as the group constellation strongly influence the learning processes (outcome) and the achieved game result (output). Regarding our empirical findings, this assumption was substantiated, because with the same region and the same task, there were very different game results—without us (so far) being able to explain exactly how the group constellation impacts the results.

Serious games facilitate, accelerate and visualize the exchange of views between various actors, regardless from the precise composition of the players involved. In the four serious game events studied here, 'shared perspectives' have emerged in all groups of players. Our empirical findings have shown that there was a strong correlation between an optimistic mood during a game round and a low proportion of "local" players in the group (and vice versa, i.e. rather pessimistic mood with a higher rate of local players). These perspectives however do not necessarily link to the larger goal of knowledge generation by experimenting and learning to promote sustainability transition processes. This would require more empirical work on the influence of players and games.

Current categorizations to identify relevant (groups) of transition actors are difficult to apply in serious gaming practices that seek to experiment with place-based energy futures. For pre-selecting players that are to be involved in a game-based scenario-making process, the Mitchell et al. [32] conceptualization of stakeholder identification and salience is a useful guidance. It helps to identify relevant players that represent the broad and interdisciplinary mobilization of expertise, resources and multi-stakeholder collaboration which is deemed necessary in energy transition [18]. Our game design, also the empirical differences in the results, have at least shown that this influence has tended to be underestimated in previous theories, also in the Design, Play and Experience framework where we miss this component. Yet, in future, more attention could be paid to the interaction of players during the game rather than to a single gamer's attributes.

We now will undertake a final critical reflection on the extent to which our game design fulfilled the requirements of the research question. It is evident that our game design permitted a more precise and differentiated observation of the influence of different group constellations on the game results than would have been possible with previous designs from the DPE. In future research, however, the research design would have to be refined and expanded to include a considerably larger number of records. Furthermore, in the revision of the design, important aspects of the energy transition that our design has not yet been able to address would have to be incorporated, including spatio-temporal system and yield differences between the various renewable energy sources, storage and distribution aspects, cost–benefit relationships, and the energy requirements of mobility.

Appendix

See Table 4.

Table 4 Setup of four gaming events, held inside and outside the location of the scenario map. Source: own editing

Gaming event (event type, date) and case ref. #		**#1. Congress Workshop during a research project [2]; 02.2016**	**#2. Congress Workshop during a research project [2]; 02.2016**	**#3. Smart City day Vienna, 05.2017**	**#4. Thematic event "Landluft" on energy transition, Vienna, 03.2019**
Venue of the game: held inside or outside the case study region?		Inside	Inside	Outside	Outside
Which compilation of players was present (Stakeholder classes (Mitchell et al. 1997, p. 21)), attributes: power, legitimacy, urgency [1])	4A-stakeholder—3 attributes (7)			1 regional manager	
	4B-stakeholder—2 attributes (4,5,6)	1 mayor (power/legitimacy) 2 local citizens (legitimacy/urgency)	2 local small water power entrepreneurs (urgency/legitimacy)	1 mayor (power/legitimacy)	1 spatial planner, 1 energy engineer (legitimacy/urgency)
	4C-stakeholder—1 attribute	1 expert (legitimacy)	1 expert (legitimacy)	1 expert (legitimacy)	3 energy experts (legitimacy), 3 students (urgency)
	4D-non-stakeholder (8, no attribute)	2 mediators from the research project	2 mediators from the research project	2 mediators from the research project	1 mediator from the research project
Details on the group compilation—per case ref		We wanted to mix representatives from politics and the civil society. The expert lived outside the region	We wanted to mix representatives from the local economy with an expert (that lived outside the region)	We had no influence on the constellation, because the players could select our game among many other interactive features that were offered at the smart city day	We had no influence on the constellation, because the players could select our game among two other interactive workshop features that were offered at the Landluft event

[1] Class 1: Stakeholder, attribute 'Power', class 2: Stakeholder, attribute 'Legitimacy', class 3: stakeholder, attribute 'Urgency'; class 4, 5, 6: Stakeholder, two attributes (Power/Legitimacy, Power/Urgency, Legitimacy, Urgency), class 7: Stakeholder, three attributes (Power/Legitimacy/Urgency), 8: Non-Stakeholder.

[2] Dumke et al. 2017. [20]

Abbreviations

DPE Design, play and experience framework
ERP_hoch3 German acronym for the research project 'integrated spatial and energy planning for smart urban quarters and regions'
GWh/y Renewable energy yield (electric or thermal energy) as gigawatt hours per year
Wh/m2.y Renewable energy yield (electric or thermal energy) as watt hours per square meter and year

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Author contributions
Author A and Author B designed and compiled the energy site catalogue and the regional energy game together. Author B mainly developed the cardboard game workshop setup, Author A mainly the underlying catalogue of area requirements on renewable energies. In this paper, Author B focussed on the theoretical part whereas Author B provided mainly the empiric documentary.

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Availability of data and materials
The data sets used and analysed during the game development are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The authors consent to participate.

Consent for publication
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