Policy Brief
Part. II: Challenges

At this point, the first part of this study offered a significant overview about public incentives at national & European levels for greener sources of energy, the nature of these available renewable alternatives & an in-deepth inspection of a specific case of next generation STE system, through the Fengtech technology.

Thanks to the EU-funded project ICaRE4Farms, the aforementionned all-new & innovative type of STE device was thoroughly assessed via on-field experimentations in 3 different countries (France (x2), Netherlands & Belgium) while opportunities have been being explored in two additional areas (Ireland & UK), in the North-West Europe.

This sample has provided sufficient information for better framing, not only ins & outs, or pros & cons of this technology, but especially the promising potential it holds for future applications in agriculture as a viable alternative for green energy supply.

However, as every innovative product, there is often a slight discrepancy between the theoretical potential, the acknowledged applications & its popular reception.
For the latter, in most of the time, environmental & cultural aspects might be hindering the proper roll-out & uptake of a breakthrough solutions. Among those motives of "underachievements", the impact of local legislations, scarce/inappropriate communications & economic context are considerable.

Hence, this section will focus upon sharing the methodological process through which the targeted system has been tested & how this approach has highlighted as well geo-technical limitations as market restrictions.

- Methodology of Assessment

As core example of next generation STE solutions in the framework of the ICaRE4Farms project, the Fengtech technology has encountered several tests & experimentations all along the initiative's lifespan. Nonetheless, each of these occurrences were not necessarily related to a strong scientific aspect. Indeed, findings & learnings about this STE device were earned alongside progress within each of the WPs & activities of the project, undertaken via 3 main focuses:

1) how does the device stand out from other renewable alternatives?
2) how efficient/reliable is the system? In which conditions?
3) how can this technology be rolled-out & popularised in the North-West area?

One might note that the sum of these interrogative hints does not reduce to scientific approaches & thus encompasses an extensive range of transdisciplinary accounts for exploring the overall potential of this innovation.
Consequently, the set of experts whose competences were mobilised in adressing these topics includes actors from all over the Quadruple Helix categories: innovative SME, business support organisations, scientific academies, communication bodies, consulting incorporations, some with

strong linkages to public authorities. As such, reports & analyses stem from legitimate & qualified interlocutors. Namely, these transnational partners are Fengtech (FR), Laval Mayenne Technopole (FR), Association of Chambers of Agriculture from the Atlantic Area (FR), University Bretagne Sud (FR), Boerenbond (BE), Cornelissen Consulting Services (NE), Northern & Western Regional Assembly (IE) & University of Lincoln (UK).
To be noted that, beyond the 3 aforementioned dimensions, prominent efforts were invested in analysing, enhancing & standardising communication & long-term strategies; besides, another cross-cutting item of study was found in specific & dedicated investments for funding 4 installations in the partners' countries. However, for the sake of the following policy-led review, these different perspectives will be embedded in the 3 main targeted questionings , due to their intertwined natures.

In such a manner, every identified hinderance will be investigated in the framework of these 3 interrogations. On the basis of the noticed "shortcomings", policy recommendations will be issued & described in the 3rd & final part of this document.

1. An Approach through Possibilities

By tackling the promising perspectives offered by next generation STE system, a first outlook sheds light upon one upfront logical hurdle: what place (& success) for STE solutions in a crowded market for renewable alternatives?
To try & respond to that sensible interrogation, an entire section of the work undertaken in the framework of the ICaRE4Farms project revolved around assessing the STE potential to survive & even thrive amongst competing technologies.

Those reflections invited to examine 3 main aspects:

(1) Sorting out the specific features of STE devices compared to other alternatives
(2) Differentiating next generation characteristics from conventional panels
(3) Evaluating how appealing is this proposal in relation with the privileged solutions of customers so far

The following 2 sub-parts of this review will naturally describe how the first point was explored & answered (a) by depicting the available competition within the renewable energy market & STE assets to strive for a key position while (b) investigating how this framework is hampered by unsatisfying policies toward access to fundings for innovation, notably.

a) Transnational Assessment: State of the Art, Comparisons & Simulations

At first, STE systems look exotic, perhaps even inappropriate when it comes to find alternatives for generating green energy & progressively get rid of fossil fuels. Instinctively, it may appear inadequate mainly because it does not produce (or at least not as effectively as other specialised devices, like photovoltaic panels) electricity; instead, it generates hot water.
Upon that basis, it seems that STE systems are less versatile than competing offers since electricity is not a main target output. And yet, only focussing upon the agricultural domain discloses how prominent the use of hot water is within much of the major sectors of Agriculture in the North-West

area.
Those findings are the earliest of many others when referring to the competition scheme in which STE devices must land on & cope with. Most of them stems from the sum of 3 activities: the Market Analysis, the Technology Assessment tool & the Case Studies.

In short:

- **The Market Analysis** was set to expose & frame the state of the art in terms of offers (& as such competitions) in agricultural sectors of the NWE area, but it also browsed through a range of domains that were deemed priority, considering their suitability with STE functionalities. At first, the document identified 5 specialised activities, namely Calf, Pig & Poultry breeding, dairy farms & greenhouses.
  This sectoral review delves into each of the NWE national peculiarities, which encompasses climatic differences, cultural & professional practices & energy prices. The countries that are analysed gather those who tackled the ICaRE4Farms partnership, namely France, Belgium (Flanders), Netherlands, Ireland & UK.
  To be noted that the Market Analysis was undertaken at a very early stage of reflections & accomplishments in the framework of the project. Consequently, it has not addressed several developments that occurred in the 5-year timespan of ICaRE4Farms; as such, the energy crisis & the ever-growing fuel prices were studied marginally to be truly taken into consideration in later activities. Moreover, since it was providing a first glimpse of the market uptake for conventional STE solutions prior the emergence of the next generation models & that the identification process of priority sectors proceeded as a theoretical matching between STE features and compatible requirements in these domains, preliminary forecasts were only indicative of a likely potential for specific sectoral applications.
  However, put together, these observations resulted in early learnings & this strong basis paved the way toward a better acknowledgement of the topical challenges & the necessary (re)actions to perform for the sake of positive outgrowths by the end of the project.

- **The Technology Assessment Tool** was designed during the 2nd phase of elaborating the Market Analysis, which suffered important delay due to the COVID outbreak, like most of the project's activities.
  Thanks to this instrument, a deeper outlook of STE comparative assets became accessible. Indeed, through a raw table of collected data & measurements as well as via a graphic illustration, a comparison can be drawn between each category of solution available on the market. Different aspects are put into perspectives, in average: energy supply performances, coverage of energy needs, levelized cost of energy, CO2 emissions, investments & other correlated metrics.
  Amongst the compared devices, the distinction is established between regular & renewable sources of energy; as follows, gas, electric & biomass boilers, heat pumps & several types of STE systems (heatpipe vaccum collectors, flatplate collectors and thermosiphon) are listed.
  Not only this quick overview sheds light upon relative advantages & inconvenients from one solution to one another but it associates this core function with several other goals:
    - Displaying variations of suitability, effectiveness & comparative interest according to the sectoral application: initially, a different & adequate version the tool has been carried out for each of the agricultural priority sectors since, depending on the type

of STE application* (direct consumption or building heating) & the specific activities undertaken, slight to significant shifts for the choice of the most optimised solutions may appear. In general, whatever the country & sector, the hierarchy of applicability remained globally unaltered even if some combinations were more competing according to the cases.

- Guiding the most appropriate energy mix: since the renewable solutions are not yet miraculous, even if they perform greater than ever supplies, it is still mandatory to complement autonomous green energy production with conventional fossil fuels. As such, the instrument provides in a quick glimpse of an eye for associating the most fitting combination of energies for supplying one's holding, by determining the right balance between need coverage, energy cost, technology investment & greenhouse gas reduction.

However, this Technology Assessment Tool was proven insufficient to point out specific applications, because of its necessary overall scope; in consequence, a third instalment was pursued to effectively conclude this global outline.

- **The Case Studies (& relating Business/Investment Plan)** were carried out to better seize the potential of STE installations in specific conditions. As such, this activity endeavoured to refine average assessment via targeted simulations on a set of diverse holdings, encompassing the 4 out of 5 initial priority sectors. Indeed, conclusions from the Market Analysis prompted the examination process to overlook eventually a specific study of the poultry sector, due to a lack of opportunities & efficiency.
  In this context, the adopted methodology was to depict valuable illustrations by capitalising upon the generated data:
  - Thanks to general perspectives from the Market Analysis, the Technology Assessment Tool & FT installations implemented prior & in the course of the project, Case Studies could explore the suitability of installing STE systems in different farms by reviewing their inner characteristics (size, activity, yearly consumption of hot water, needed temperature, etc), STE forecast performances (solar irradiance, coverage rate/number of panels, energy savings, etc) & investments (cost of equipment/installation/site preparation, available subsidies, yearly loan payment, ROI(C), yearly earning, etc).
  - This scheme is applied to 2 scenarii, which are No/Available Aids hypothesis. This distinctive analysis evokes two very different pathways as access to subsidies can really alleviate the significant economic weight of purchasing a plant of STE systems, especially when required dimensions are consequent.
  - Eventually, this template was transpose into 17 case studies, heralding as much localised examples in different activities, countries & climate. They all have been categorised into several set, advertising their degree of accuracy based upon empirical experiences. Thus, the more theoretical examples are listed in the 11 Academic Case Studies pool (4 in France, 2 in UK, Belgium, Netherlands, 1 in Ireland) - to be noted that this discrepancy in terms of number stems from variable priority sectors depending on localisation & professional habits; as such, each country has its own promising sectors among the overall identified ones and they can vary from one another. The second set revolves around French Field Application Cases whose data

have been collected & refined from pre-existing installation in each of the French priority sectors, except Greenhouse. The last pool corresponds to the most accurate & concrete case studies since it illustrates 3 examples from Britanny that were installed as complementary sites in the framework of the project; as such, these analysis benefit from a long-standing experience, the latest system improvements & official scientific supports. French Calf Field Application Case can be filled in the two latter categories, as it is adapted from the French Pilot Site.

- These Case Studies were converted into Factsheets for communication purposes & capitalisation.

This review of activities dedicated to Assessing the transnational potential of next generation STE systems sets out the thorough methodology of actions & evaluation that was undertaken to shed light upon the previous state-of-the-art & the promising future in the event of rising rolls-out & uptakes for STE solutions.

As it is about to be described more in depth, this first stage of study provided the necessary hints for framing the field of opportunity for STE broader implementation in the NWE Area.

b) Practical Hurdles in Existing alongside Compelling & Competing Solutions

According to the Market Analysis, there are around 850 000 farms distributed among the 5 project countries from the NWE Area. More precisely, it is estimated that at least 29 480 holdings in this territory could be optimal candidates for implementing STE systems (FR = 10720; BE = 2460; NE = 3800; IE = 5400; UK = 7100). In comparison, at the project's launch, Fengtech stated that 30+ farms were equipped with their next generation STE systems. These holdings were mainly concentrated in the Mayenne County, with a few more in neighbouring counties from Pays de la Loire & Brittany Regions. Even though Fengtech has been developing & selling its devices for 10 years, his status of very small SME must be considered. These proportions express anyway the core challenge faced by the expansion of STE solutions: infiltrating successfully the Energy Market.

According to a survey from the General Commission for Sustainable Development back in January 2021, Photovoltaic solutions accounted for 3.1% of French energy supply in 2020 while STE systems only represented 0.7% of the available Renewable Energies. This concrete example demonstrates how (1) renewable energy are still struggling to catch up conventional fossil energy in terms of supply percentage & (2) STE technology is particularly lagging behind its more famous counterparts. This observation is even more marked in other European countries, especially the ones located in the NWE region.

Stemming from this analysis, the challenge can be divided into 2 overlapping hinderances: STE systems are not as well promoted & supported as photovoltaic technologies. Concretely, despite a manifest readiness level, every focus undertaken has shed light upon the fact that STE devices is far behind in the race for renewable energy best options, even though its potential is huge!
If market-related hurdles will be tackled in the third section of this part, the early stage of market access, i.e. conception, development & first contracts in a competing environment, will be processed as follow.

Amongst the main hurdles materialising barriers to overcome, several questionings revolve around:

(i) One-stop Shop Dynamic for Certification

As of today, the NWE certification landscape offers contrasting views for its delivery process. On the basis of project countries, 2 observations can be drawn:

- Certification is crucial for accessing to fundings in installing renewable energy devices
- Access points are foreclosed under a logic of one-stop shop

Several examples illustrate those conclusions among the project's findings & learnings on the subject:

- In France, ADEME is in charge of granting subsidies to a selected range of energy solutions. Their expertise encompasses supply as well as savings, building rehabilitations & CO2 reduction. As the Association for the Environment & Energy efficiency, it represents the one & only institution deciding upon financial shifts & schemes for public incentives towards energy management, especially in a green transition perspective. Stemming from that situation, it is remarkable that any demand of subsidy in this sector go through the ADEME processing, monitoring, assessment & decision. As such, this dynamic entails that any denial, if not irrevocable on the longer-term, does not open any alternative dialogue with empowered counterparts. Moreover, since the certification embodies a major, even a *sine qua non* criterium for benefitting from ADEME subsidies, a first market barrier arises on this localised ground. Consequently, tiny enterprises like Fengtech are facing a first setback for their early market development since any grant is dependent of being registered as a certified energy solution provider. The point will be explored further on, but due to this situation, alike companies are suffering from a lack of subsidies that foreclose their competitive potential on the market. Considering that between 40 up to 60% of expenses (equipment & installation costs) can be covered through these funding schemes, the market competition is unbalanced as this framework hampers competition by preventing newcomers to be on par with pre-existing paramount actors who had the resources to undertake the certification processes for securing their position.
- In the UK, the Department of Energy & Climate Change is accountable for administering & granting access to subsidies through the requisite of certification.
- In the Flanders, the Flemish Energy Agency manage the obtention of subsidies.
- In the Netherlands, the administrative body for public aids is the Dutch Ministry of Economic Affairs. The specificity of this country relies on a lack of national & regional aids, explaining why EU projects & affiliated funds are actively sought for (co-)financing Dutch initiatives. However, there is a Dutch subsidy available for solar power systems: ISDE. This system however relies on the availability of certification for the applied system. As such, the certification, or proof of the certification process, is also very important for acquiring the permit for a (pilot) site.
- In Ireland, the Sustainable Energy Authority of Ireland handles the role of main one-stop shop for accessing to energy finances.
- From the project perspectives, the French logic description appears very similar in the organisation within the other countries.

As such, these illustrations depict how the certification criterium represents a significant hurdle for accessing a competitive market where new solutions have to face both internal (STE devices only) &

external (other energy offers) competitions. This framework fosters the entrenchment of longstanding actors & technologies, at the expense of innovative alternatives.
Thus, the current analysis stresses unbalanced regulations that disrupt the EU fair competition principle & a sustained innovation dynamic. The correlated challenge of endogenous factors composing this criterium will be discussed later.

(ii) Recurring procedures for accessing recognition in new territories

Another pitfall in undertaking certification procedures in Europe relates to the obligation of renewing the process for each national market that are sought to be entered. The absence of certification interoperability jeopardises export prospects as well as it nurtures logics of foreclosed competitions between & within each Member-State.
The situation is paradoxical as well as it is recent:

- The European Standard for Energy Solution (ETV) was a certification mechanism allowing an efficiency recognition of the technology, on a broader scale. However, this programme ended in late 2022 because of an unsatisfying & decreasing number of periodical applications. Beyond a potential lack of visibility, this conclusion can be nuanced by a qualitative observation of its content.
  Indeed, in terms of scope, the mechanism was in definitive mostly useful for a limited international recognition rather than a more specific European one since the certification really opened access to US & Chinese markets. In Europe, many countries were eventually not giving any credence to the label, by prioritising lower-scale accreditations.
  This scenario was really unfortunate given that, in terms of content, assessing the efficiency of the solution should be the paramount target for any certification process. And from what it leaks, the ETV was the only mechanism aside from local & regional ones to focus essentially on the production capacity factor. This asset has to be mentioned considering how other uncompelling criteria are commonly chosen for evaluating certifications.
- The SolarKeyMark mechanism appears as the only viable alternative for certificating new energy technological solutions at the European scale. However, this procedure entails one major pitfall that may prompt anti-competitive effects, as well. If this certification process covers geographically the European territory, it only focuses its analysis upon a review of components of the solar collectors but barely their arrangements. In short, this examination leads to assess different steps, including the production chains & the assembly of the constituting parts in order to ensure that forthcoming replications are compliant with all guidance criteria, hence underlining a guarantee of valid & faithful product.
  As a direct consequence, when inventors are just a privileged (yet not optimally effective) retailer of their own solution, they are compelled to launch the certification process with their producing intermediaries. Naturally, this running system is flawed on several aspects:
  - On one hand, as long as the inventor does not have a direct control over the production, the certification has to encompass several actors; this condition become problematical when more than one producer may be involved : indeed, the more factors, the longer all those procedures are likely to take & it may jeopardize the timing for sustaining one's company activity as how pivotal the resulting related subsidies have been highlighted

- On the other hand, locations can anyway raise a problem in terms of accessibility & time: territories outside the European jurisdiction may pose hinderances slowing down the process of verification, especially in diverging political regimes while some external States are renown for producing a wide & cheap range of products
- Beyond those hurdles of Multiplicity & Transparency, another barrier lies down the path of Intellectual Property Rights: these demanding procedures may impel inventors to cede their ownership over the more economically resilient production company in an intent to ease their burden & the procedures but therefore, it would also considerably endanger their position as well as compromise their exploitation & exclusivity rights
- Last but not least, the core problem of the evaluation criteria for this certification scheme relies in the pure absence of efficiency & effectiveness review at the whole system's scale; by focusing exclusively on components of the solar collectors, this certification process disregards the main interest & indicator for customers & society: innovative, green & sustainable energy alternative! And all the fossil energy savings coming along.

As exposed, amongst the rare two possible entry points for broadening the European-wide roll-out of the energy solutions, the conclusions are really unsatisfying considering that one way is inconsistent with economical & societal requirements while the second one has mysteriously vanished, despite its qualities...
In front of these appalling observations, it emerges that any economically precarious newcoming inventor is confronted with hard-to-overcome bullwarks preventing one's, very likely, to reach a sustainable, viable & successful achievement.

(iii) Lack of Communication & Access to Information

STE systems are still an overlooked alternative in the green energy market: either because efficiency results & the related reliability were not on par with competing technologies or because the supply of direct thermal energy (hot water, hot air) instead of direct electricity has raised some interrogations. If impacts over markets access of an insufficient promotion will be tackled in the third part of this review, it is already possible to take a glance at the wider effects of overlapping communication upon:

- Recognition of STE specific effectiveness
- Incentives & Information towards (a) developing new STE devices & (b) accessing installation subsidies

Hence, those two interconnected aspects interact into one main conclusion: the bare subsistence of STE solutions on the market depends largely also on communicating the right information & propelling appealing indications about available support for correlated initiatives. Unfortunately, one might lament about the isolated promotion the STE devices are suffering from: much of the spotlight is monopolised by more familiar technologies like PVs & this hegemony is nurtured by cause promoters in the energy domain. This easy way-out logic revolves around a *statu quo* that curbs the innovation dynamics in the sector by upholding the same privileged solutions & lowering the risks. However, a shift has been noticed along with the Energy Crisis arising from the Ukrainian War; the desperate need for retrieving an affordable energy supply has led to more open-minded & less risk-averse patterns of

search & selection. Linked to the aforementioned certification shortcomings identified for STE solutions, the lack of communication & the low official recognition necessitated to grant subsidies are mutually reinforcing and prevent a favourable upturn from happening. Indeed, taking into account the French example, the certification process does not cover sufficiently STE applications for accessing to aids and consequently, the communication about fundings possibilities are dampened.

Thus, amongst all the activities that were tackled in the framework of the ICaRE4Farms project, a particular emphasis was built upon communication. Quite immediately, the urge for educating stakeholders over the core difference between photovoltaic (electricity) & solar thermal energy (hot water) appeared pivotal for raising awareness about its potential & promising applications. A set of several actions was deployed to nurture information about STE:

- *Factsheets*: several documents were produced in order to offer specific, concise & visual outlooks on a country & sectoral basis
- *E-Newsletter*: on a semestrial periodicity, news were summarised & transferred to every interested stakeholders for their information
- *Info-Days & Dissemination Events*: several events were organised or attended to promote the use of STE as a viable renewable energy & disseminate the project's results appropriately
- *Basic communication materials*: back-up elements for promotional purposes were deviced in order to extend the range of STE renown
- *Videos*: Educational videos were recorded to broaden the audience of STE users & stakeholders, by depicting all its potential in action; to that extent, "Getting into hot water" video was specifically designed for serving this purpose
- *Information Campaign*: in parallel of dissemination events & relying upon all the produced documentation for STE promotion, special efforts were undertaken in entrenching on the longer-term STE reputation by summoning renewable energy associations & local utilities as intermediaries for dissemination support
- *I4F Community via the socials*: a full-fledge strategy of community-building was carried out to secure a critical number of interested stakeholders on the longer term; this tactic came to fruition for gathering nearly 500 followers on the project's social medias & providing them with frequent content, news & updates.

Nevertheless, it has to be pointed out that the project's initiatives, in regard to its communicational axis, remain isolated efforts, despite its transnational nature & EU support. If findings & learnings stemming from the project might be crucial for a paradigm shift in favour of a more fairly balanced support to renewable energies, its enlightenments may be overshadowed by enduring habits to privilege common RE solutions benefitting from sustained channels of communication.

(iv) Overlooked allocations of subsidies for STE / Marginal funds for subsidising

Last but not least, all 3 aforementioned & identified challenges (namely, (i) exclusive national pathway for certification recognition, (ii) limited cross-national certificate & (iii) promotional & renown pitfalls) collide into one last aspect: a marginal allocation of subsidies dedicated to STE technologies. Indeed, most of the certifications either do not match adequately with the STE devices or are instinctively overlooked as an appropriate alternative for supporting one's initiatives.
As said before, the 3 main challenges identified feed this situation, but it is also interesting to remark

that for instance in France, the “Fonds Chaleur”, the most accessible & versatile subsidy for Renewable Energy uses, does not officially include in its range of grants the STE technology. The ADEME, which is among other things in charge of this aid, has stressed in that case that since STE systems were not deemed efficient & compelling enough, the current scheme was not open for supporting this technology. However, if strong proofs are brought to analysis, this standpoint can evolve & lead to an overhaul of the next grants’ eligibilities. Not being able to count on an up-to-30% subsidy is naturally a fierce barrier for STE SME companies to overcome, considering the inner cost of this kind of solution. Fortunately, rules are a bit looser on smaller scales: in France, regional funds exist & can provide support on a local & exceptional basis, as long as criteria are filled in. In Brittany, the PCAE, standing for Competitivity & Adaptation Plan for Agricultural Holdings, represents a privileged channel of financial support for a sustained roll-out of the STE, despite the rise of other hurdles relating to innovation scepticism, to be addressed in part II. Even on a more local basis, opportunities appear punctually. By taking a glance abroad, conclusions are mixed:

- In Ireland, STE suffers from absolutely no incentive since PV is the gem of the crown for everything relating to RE. This standpoint was furthered lately with a new legislation, Targeted Agricultural Modernisation Schemes (TAMS), enacting almost officially the hegemony of PV solutions for fighting the climate change. Indeed, this regulation support farmers in installing PV plants with battery storage on their farm; it is eligible for every agricultural sector. As such, STE entrenchment, but first, roll-out seems quite difficult in Ireland because of these prominent barriers.
- In the Netherlands, few national & regional grants exist in general & so it does for supporting RE investment. However, amongst the available schemes, criteria can be quite strict: it revolves mainly around certifications & placements of the system (De Zonneladders legislation & its range of processes depending on the type of surface to be equipped).
- In UK, the combination of both Brexit & Energy Crisis has prompted government & local authorities to seek for more affordable alternatives.
- In the Flanders, several funding schemes exist but they cannot be combined.

Consequently, this NWE outlook illustrates how available subsidies for STE go from adverse behaviours & scepticism to scarce or exploratory interests & ad-hoc opportunities. Thus, the current framework is inadequate compared to the potential of STE solutions.
The globally expressed reluctance toward STE technology has triggered a counter-productive climate for its overall uptake which need to be corrected by confronting concrete results of efficiency. This work entails a scientific & academic back-up for proving the validity of next generation STE systems potential. To that extent, a perspective upon innovation through precise measurements & thorough assessment was a must-have process for the project to embed for disclosing the technology true capacities.

2. An Approach through Innovation

When diving deeper into the technical characteristics of next generation STE systems, another natural question comes to one’s mind: what advanced specificities may enable these new technological updates to supersede classic models & cope with adverse conditions for providing a satisfying energy

supply?
Replying to this questioning will cover a whole dedicated section whose goal will be to mobilise technical knowledges & empirical findings stemming from pilot site audits in the framework of the I4F project. This collection of learnings will enlighten how next gen STE systems intend to level-up above the mass of existing solutions to establish its "predominancy".

Those reflections compel to tackle this challenge under a 4-step perspective:

(1) Developing a thorough methodology of energy monitoring for seizing the exact STE potential
(2) Implementing tests & experimentations on pilot sites for crossing theoretical & real-life results
(3) Elaborating faithful modellings of functioning under several relevant scenarii
(4) Framing the design rules for optimal on-site configurations & specifications

Basically, this scheme of investigations has modelized the roadmap of actions intended by the scientific team operating on the more complex technical aspects of STE systems. As highlighted, the scope of actions voluntarily adopts a global system approach. In consequence, this pattern of analysis offers an in-depth outlook for (a) assessing scientifically the superior assets of next generation STE devices compared to classic solutions & (b) gauging how interest for an ever-expanding performance meets no sufficient targeted efforts from the policy innovation schemes, on a specific basis.

a) Demonstration & Monitoring: Methodologies, Instruments, Data, Models & Improvements

All RE technologies set aside, the next generation of STE systems displays promising assets that foster a prominent evolution gap with previous prototypes. For instance, one main aspect this solution was criticised for & led to an unwavering reluctance about investing in it, was its poor adaptability to adverse climates. Indeed, such devices were no fit for overcast or cloudy weathers, which are typical in the upper hemisphere in which most of Europe is located.
However, with the innovative efforts to develop more up-to-date & efficient technologies, this major pitfall receives a valuable remedy: next generation STE systems, like Fengtech ones, are specifically designed to conquer more territories thanks to the combination of components & ingenuous synergies. Among those advances, it has to be cited the sum of in series & in parallel units' installation, storages, tilt angles & albedo.
In short, in series positioning enables the system to harness the thermosiphon effects which naturally push the warmer water from one tube to one another, and from one unit to another as well. An optimised tilt angle of 45°, orientated preferably toward the South (or at least South-West), enhances the capture of direct & diffuse solar irradiances. Besides, thanks to a white surface, serving as the mere ground on which the plant is settled, the system also benefits from an improved albedo effect, which materialise into an increased yield in terms of reflected rays.
This association of innovative features, along with the high-performance storing capacities of the system, unveils a first look at STE true potential. It undoubtedly emerges through one paramount proof of efficiency: next generation STE systems are guaranteed to provide at least 50% of the energy, when the plant dimensioning is sized accordingly to the holding surface / activity range.
Therefore, one might wonder how these observations can be monitored & more importantly, scientifically validated. These outcomes stem mainly from a set of 4 correlated scientific protocols of measurements & experimentations:

- **Methodologies for Procurement of Instrumentation & Control Experiment Database** / This first methodological step entails to frame the most adequate instruments for carrying out the measurement while also retrieving empirical data from a sampled real case; it encompasses 4 distinct pre-requisites to secure a thorough basis of analysis

  - *Selection of the site instrumentation*: This preliminary review is crucial for ensuring that every relevant & influencing parameter is considered in varying measurements over time. Thus, a special emphasis has been stressed over gearing up with monitoring equipment to calculate the impact of climatic conditions, operating settings & energy production. As such, factors like wind, moisture or solar irradiance are carefully analysed for determining at which degree they affect functional parameters like flowrates, temperature & pressure, impacting directly the energy efficiency of the system. Pre-auditing a real-life scenario is key to collect a set of reference data from which an initial model can be built & then refined.

  - *Reporting the fluctuations of the energy balance all year long*: This second sequencing of data revolves specifically around energy shifts depending on seasonality. Since climatic conditions are changing depending on the time of the year, a correlation must be drawn between static factors and their evolution according to the period of the year. These ever-fluctuating settings are important to take into account considering how some activities, especially in the agricultural sector, are concentrated over a precise time-period; consequently, being provided with a clear insight of the energy production potential on a daily, weekly & monthly basis, with seasonal patterns, helps to assess whether the *t* moment where the energy supply is optimal corresponds to the time where energy needs, stemming from activities, is maximal. In other words, “scheduling” the periodical efficiency of energy production sheds light upon the variable compatibility of agricultural sectors in sustainably installing a STE plant. As a result, those preliminary elements hint at a first model for predicting energy production behaviours, over a specific yearly template.

  - *Compiling & Retrieving via a database the required information for model validation* *The third aspect of this* programme revolves around identifying & collecting the performance data for two sets of arrangements: a single solar panel collector & the whole system installed in series (& parallel, depending on the next generation STE version). As stated in the introduction above, the mere specificities & advantages from this new kind of devices rely not only upon a special mix of components but also on the combination of several interconnected panels, per plant. Unlike seasonal settings, these parameters are static & do impact the energy production proportionally to the sum of arranged panels. Obviously, the thermosiphon effect, at stake only when the plants run with at least 2 panels, offers a cumulative impact over energy efficiency & supply. Acknowledging the peculiarity of innovation through a “package” approach rather than a stand-alone operation is key to understand where the STE true potential lies & to consider the prominence of cumulative add-on that a

too straightforward & focused analysis would overlook.

- *Diversifying the environment of collection & Showcasing an easy-to-displace proof of concept through the design of a portable STE device*
  Whether the 3 previous stages of the Acquisition Methodology relate to the monitoring equipment, the seasonality parameter & the combination principle for next generation efficiency, a fourth dimension requires a thorough emphasis: impact of geographical locations. Indeed, the main influential settings relating to weather conditions, namely solar irradiance & temperature, differ on a spatial basis. Not only this divergence exists between countries from a same area as the North-West Europe perimeter, but it covers also localities & sub-territories with an insightful discrepancy sometimes. Consequently, a portable system has been elaborated by our English partner in order to easily & conveniently test the technology in several places, without cumbersome issues & in support to simulations. This experiment thus displays two major interests: it can help to refine measurements & to optimise assessment carried out via diagnosis tools on a wider basis than the 4 pilot & other additional sites. Moreover, it can serve as a handy demonstrating instrument thanks to its portability, for showcasing to a broader audience that would not be in position to travel to permanent sites* (especially for the British Isles which does not benefit eventually from their own).

- **Application of an Optimised Acquisition Strategy to the Project Pilots**
  Basically, most of the above-mentioned logics are to be replicated, at least transposed, in a refined manner, from the pre-audit site to the 4 pilot sites, all set in different regions/countries. What was the main hardships to overcome was to procure instrumentation & ensure its monitoring from 4 different places simultaneously.
  According to the uses, a specific list of procurements was drafted then enforced to comply with each sectoral requirements, notably in terms of the STE plant dimensioning.
  If another set of pilot sites was planned initially, diverse aspects to be discussed in the coming lines have been challenging enough in the project lifetime to compel a slight overhaul of this selection.
  In the end, efforts have been undertaken to effectively install 2 sites in France (all in Pays de la Loire region / 1 in the Sarthes County & 1 in the Anjou County), 1 in Flanders & 1 in the Netherlands. The French sites are 1 Calf & 1 Pig Farm, the Flemish holding also hosts Calf breading activities whereas the Dutch one applies STE production to pre-heating a biodigester.
  This distribution provides an exhaustive outlook of the North-West Continental Europe perspectives by depicting 4 close but different environments with peculiar climates. Above all, it ensures an equal review of STE 2 main applications, e.g. direct consumption & building heating. Despite some redundant sectors, e.g. Calf farms, professional differences & cultural habits legitimate the cross-analysis of one same agricultural domain in diverging national frameworks.
  However, 2 pitfalls are to be deplored: this harsh-to-secure selection entailed that few prominent sectors had to be left behind despite their promising potential, at least in a pilot site context (it is namely the Dairy & Greenhouse sectors). On the other hand, any

representative site from the British Isles is missing & would have given a complementary prospect upon the regional climatic specificities to the broader NWE picture. As detailed later on, success & shortcoming of the project's initiatives & actions are speaking for themselves by disclosing insightful findings for market deployment.

- **Modelling of System Functioning & Operations**

Both testing of the Acquisition Strategy in the pre-audit phase & its applications on the 4 pilot sites paved the way to building up theoretical models to frame STE systems performance & scalability. This simulation toolkit was meant to receive updates & optimisations in accordance with real-life pilot results. Considering the crucial importance of forecasting the expected hot water production & energy savings, resorting to a trustful & accurate simulating instrument has been a core objective of the project.
Hence, 4 numerical models have been developed to frame behavioural patterns of STE operations:

- The first 2 standard templates serve as a basic framework displaying the regular functioning of either a single STE unit or a whole system.
  It is meant to single out the singularities of operations between the stand-alone & systemic functioning while predicting the core applications that can stem from this inner operating process.
  It represents the most generic approach for seizing the promising uses of STE plants.
- The 3rd model focuses upon assessing the efficiency of an application in direct hot water consumption. It thus describes how the energy production is expected to behave according to several incident parameters relating mainly to local weather conditions. This account prevails in activities like cleansing or feeding, for instance in Dairy & Calf Farms, 2 out of our 4 main identified sectors of interest. Yet, it provides the necessary simulation outlook to explore further domains, even beyond the agricultural sphere.
- The 4th modelling relates to applying STE for building heating. It entails to be geared with hydraulic heaters equipment. As such, it translates & displays how climatic settings are expected to impact the STE performance on this peculiar use. Doing so, it highlights a set of additional possibilities beyond the project's scope of Greenhouse & Pig Farm typical applications.

- **Continuous Monitoring of STE Sites for Refinements & Improvements**

This last step refers to learning from modelised patterns of functioning & on-field arrangements for paving the way toward more efficiently arranged plants. Concretely, it entails to tap the farmers' feedbacks over their site operations in the framework of the project & the hints toward improvements noticed by the scientific team all along the initiative. These materials should enlighten the prospects of further technological upgrades & new fields of application for next generation STE solutions.
Indeed, by being able to predict with accuracy the energy supply tendencies, depending on the activity sector & the geographical location, a blueprint for optimal operations would be

issued. On that basis, technical expertise on field & users' standpoint will provide insights for enhancements & it will result in thorough review of the executed design rules. Consequently, it will fuel the reflexion for more flexible, comprehensive & adequate configurations, scales & combinations of STE parameters (regulation mode, installation steps & process, storage size, etc). Thanks to this design-optimisation process, the official guidance will be renewed, the all-new guidelines will ease a tailor-made implementation of STE systems at full potential & the complementarity with other available RE supplies will nurture the search for a case-to-case perfect fit.

Ultimately, Ultimately, this scientific 4-step protocol sheds light upon the monitoring, measurement & follow-up methodology undertaken in the course of the I4F project. If these above-mentioned actions have underpinned accurately the concrete efficiency of next generation STE systems, this technology remains underrepresented due to a lack of visibility & recognition, compared to star renewable counterparts like PV solutions. This situation is entrenching a stalemate at every notorious steps of STE breakthrough: first, at the ideation level, during the process of opting for a cutting-edge solution rather than focusing over more famous alternatives; secondly, at the innovation stage, where solutions must be found for enhancing standard prototypes towards new highs; eventually, at the market roll-out scale, when notoriety & performance requirements collide for grasping sectoral shares and hope to thrive.
At this point, the second aspect has to be further explored to assess how a compelling solution still lacks official & sufficient support in its innovation dynamics.

b) Practical Hurdles in Standing out on the Longer-Term

In virtue of the outcomes stemming from the Modelling Study, the current next generation STE systems effectively appear as a new step beyond when it comes to energy supply performance. Indeed, by calculating the water flow rate & the energy production, with respect to water quantities & climatic conditions, those numerical models have exhibited the ins & outs of the system's operations, in different sectorial scenarii. This approach has been pivotal for pointing out several findings relating to STE solutions:

- The theoretical models that were developed are extremely faithful to reality, with a relative error margin never exceeding 10% and located in average between 2% & 7%; the gap can be linked to sudden & unpredictable shifts of weather patterns.
- Locations & their specific climatic conditions obviously explain most of the discrepancy in terms of energy outputs between different sites; however, even if the tilt angles & orientation parameters affect moderately the final energy supply, they must not be overlooked since their adverse & favourable combinations display divergences beyond 15% of additional production.
- The remaining differences between simulation & real-life results expose some hints for keeping the optimisation efforts on
- Sustained dynamics of innovation lead to technological advances at a constant pace, hence, new upgrades or even evolutions of an existing solution may start emerging before the full potential of its predecessor is totally framed

These observations highlight 2 main learnings :

- STE solutions efficiency is validated scientifically, though it does not suffice to erase the reluctance of the public authorities' opinion
- Innovation follows a random & hazardous path: it can be short-lived before getting supersede by a better perspective, it can take years to develop & be taken up or it can become an abrupt revolution, overwhelming every other competing views

In the next generation STE case, the 2 previous conclusions underline a fourth option: innovation is a frequent flow that can survive for a long period without a market-wide success but that desperately needs public support for living & thriving. Here follow multiple remarks on how much inadequate & unsatisfying the policy innovation schemes stay too modest in comparison with a high rate of missed opportunities.

(i) Time-consuming, Scarce & Uneven Distribution of R&D subsidies

The NWE landscape of financial schemes heralds a strong variety & sources of subsidy mechanisms for supporting innovation in its diverse forms, in appearance. Indeed, beyond most of the elements that were introduced in the first part of this review, when scratching the surface of the available fundings to be granted, one must resolve to face a multi-faced & disconcerting truth:

(1) Award-access is hard to capture with a very competitive research sector where the likelihood of grants rarely exceeds 20% of success
(2) Research & Development schemes remain quite scattered in the public sector
(3) R&D calls, programmes & projects are both expensive & highly demanded, which result in an overwhelming workload of administrative tasks for completing the application forms

Stemming from these observations, innovation is forcibly dampened by multi-speed barriers. Considering the status of the applicants, and their relative access to resources, the gap to overcome appears bigger & deeper. Furthermore, innovation is a capricious path that take time to come to fruition & necessarily require multiple sources of an overall limited number of financial supports for likely thrive. Hence, this whole set of overlapping parameters merge into another paramount market barrier to entry, especially targeted to modest inventors from start-ups or SMEs. Thus, big conglomerates monopolise the spotlight & it become even more difficult for small entities to shine and concretise their ambitions innovations through dedicated funds.
At the European level, the scarcity & misdistribution is quite marked because most of the available public schemes revolve around European project calls. Moreover, not every programme embeds specifically in its scope an R&D focus. In fact, it is the Horizon Europe framework that encompass mainly this topic, as the heralded prime EU instrument for research & innovation. As such, it is "solely" 95.5 billion € for a European-wide ecosystem of 27 countries, plus all foreign partnerships, i.e. nearly 23 million of companies & 280 academies. In the meanwhile, the R&D department of Google has a yearly budget of 16.6 billion € on its own...This long-standing debate implies a fierce race for each entity to secure its share of the cake.

(ii) Lack of institutionalised Innovation Hubs for cross-sector collaboration

If multi-disciplinarity is an ever evolving & ongoing process in our society, it remains largely unnatural & rare, or inadequate enough, to foster an intuitive, sustainable & fruitful cooperation between the 4-Helix sectors. Learnings from our business support organisation partners shed light upon the fact that some sectors are far more impervious than other, both with counterparts & outer expertise. For instance, this remark applies particularly to the academic & scientific sector: either with other labs or outsider entities, contact is not a genuine reflex. Consequently, knowledge-sharing is dampened because of the artificial barriers that arise, due to a lack of communication & initiative on each side. The search for openness might be however nurtured by intermediary institutions whose inner endeavours aims at bridging the existing the gap; nonetheless, this kind of initiative relies upon uncompelling frameworks whose flawed schemes do not propose the appropriate means & strategies to foreclose long-standing & virtuous interactions. These observations stem from both poorly institutionalised hubs & underperforming content / action plan of these configurations. Yet, actions undertaken in the project have disclosed that innovation center logics can emerge more effectively by framing fitting programmes where stakeholders are keener to mobilise their efforts. In regard to this goal, selecting famous & renowned events, conventions & labels were key targets for securing a satisfying outreach towards institutionalised circles of peers & expertise beyond. As such, aside from the project regular communicational tools & channels (exposed in the dedicated section of the previous chapter 1), a specific emphasis has been focused upon the redaction of 5+ academic articles covering every scientific topic relating to the project actions & the participation to 5+ national & international congresses. Each of these actions were transposed into “adapted” communication with the firm objective to debunk the esoteric scientific language & make it accessible to understand by every type of relevant stakeholder. The Feasibility Tool, discussed later, is a typical attempt toward popularising those knowledge & facilitating common understanding for cross-sector collaboration, though a translated language. The same intent apears through the present report & several official meetings for the Policy audience.

(iii) Inadequate standards of certification

Earlier on in this Policy Brief, it was discussed how access to subsidies was mainly dependent of a proper & acknowledged certification. If this argument remains strongly valid, an overlapping point needs to be deepened: the criteria of eligibility. In such a manner, a quick transnational review helped to frame different patterns:

- On a local/regional basis, existing subsidies favours either innovation, environment & performance or correlated ends; for instance, in France, regions like Brittany grant the PCAE aid which aim at supporting the modernisation of agricultural equipment so that economic, environmental & efficiency ambitions might meet appropriately
- On a national perspective, funds might be harder to earn & 2 main scenarii exist:
    - At a country level, subsidies are mainly controlled & assigned by a one-stop shop regulator (for instance, ADEME in France / see the eponymous sub-part in chapter 1)
    - Regional aids are correlated to national directives; hence, some criteria might change from one territory to one another. It explains why PCAE scheme has been more systematic to secure in certain regions like Brittany but purely unavailable elsewhere, like in Pays de la Loire region for instance.

    - A side aspect to consider refers to building permits. If this topic will be further described in chapter 3, it is important to underline at this point how permit legislations can alter significantly the opportunities of installations. For instance, in the Netherlands, De Zonneladder regulation hinders profoundly the likeliness of STE deployment, due to restricted areas for implementation. In Ireland, it is the TAMS II regulation which informally heralds PV systems as prevailling solutions, at the expenses of other green alternatives.
- On a transnational / North-West Europe outlook, rarer & rarer certifications can be accessed but they are more & more demanding while globally targeting inadequate pre-requisites.

By focusing upon the latter element, one might notice the inconsistency of those proposals. *Considering the certification landscape available at the European stage (except fundings from EU programmes), every following observation revolves around the SolarKeyMark label:

- Certification processes barely take into account the inner performance of the technology: Assessment rather focuses upon the features & origin of the core components (solar collectors) of the systems than asserting the innovative combinations (system) of concepts leading to breakthrough results;
- This misguided evaluation roadmap hinders true potential to shine: by overshadowing performance & quality by compliance with arbitrary rules preventing small inventors to enter the market, a barrier is artificially set for technological advancements
- Innovation cannot blossom because of a two-speed paradox: Current EU certifications (& some national ones) seek for innovative approaches to contemporary issues but they overlook pecuniary aspects compared to environmental dimensions; foreign supplies awake added vigilance because of the possible opacity of the solution but it should neither jeopardize the quality review of the presented components nor induce forced collaboration leading to an unfair IP shift, from the inventor to the larger producer.

(iv) Harsh-to-foster International Collaboration

EU-funded projects are the main paramount source of collaborative schemes available at the European stage. Aside from these steppingstones, few possibilities alike exist... At least, they appear even more complex to successfully tackle: 20-25%, this is best imaginable rate for getting awarded a EU project proposal. This score is however very often below this record threshold. On contrary, little to few European projects really grasp the opportunity to expand their findings & upscale their outcomes for the benefit of the whole continental, even worldwide, society.
This paradoxical situation can be summarised as follows: uncertain efforts prompts little to no concrete & longer-term impact. Innovation is a capricious path & a long awaited trophy; however, European funds remain insufficient & too much misallocated for propelling real disruptive shifts. They embody a first welcome draft but not enough efforts are invested in ensuring a tangible legacy & visible breakthrough. Either because of inadequate timeframes or due to a lack of consistency & follow-up, too much fundings are spent on too minor technological details & connections between correlated projects lag behind when it comes to measure a full-fledge impact.

This conclusion is even more appalling that it entails an even greater difficulty for small inventors to cooperate worldwide & cope with an even broader, more compelling & tenacious competition ground.

To conclude this part, the inventory of scientific actions & measurements has enabled to prove & guarantee the inner effectiveness of next generation STE solutions. Above all, this official academic acknowledgement has set a precedent for considering STE systems as proper green alternatives to capitalise upon. However, this progress in terms of recognition still need a broader shift of mindset from the society as a whole, and this end can only come by steering new habits for authorities & citizens. One step after one another, it is now required to delve into the potential of conquering & standing one's ground in the European "energy" markets.

3. An Approach through Markets

Over the full length of the project, three aspects of the product market strategy were clearly transpiring: not only its existence & its superiority were key for its success, but it also more importantly demanded renown. Quite a quality comes however at the price of communicational & development efforts in order to capitalise appropriately upon a certified performance of supply & undoubtful satisfaction of the customers. One question has been persisting though: how a breakthrough technology could invade an allegedly foreclosed market of sustainable energy with success?

To seize the full picture, it is important to realise that technological assets are not pivotal on their own & need further additions to reach the device's optimal outreach:

- Anticipating both in advance & all along operations the exact efficiency of one given installation
- Gathering a community of "quality-insurers" through the outburst of reference sites, serving as living showcases
- Expanding the available installations to nurture a network of fine-tuned experts

Through these complementary means, one technology maximises its chances to get a strong foothold in the market. Nonetheless, promotional support from a multiple basis of stakeholders embodies the best tactic for ensuring a viable presence on the market. In that manner, the following report intends to deliver a faithful testimony of access-to-market experience, through a project's feedbacks perspectives. In consequence, this part of the Policy Brief will revolve around (a) framing the market conditions & pre-requisite for STE deployment in the NWE agricultural field while (b) exploring the main motives for a hindered STE expansion through Europe.

a) Deployment: Development of Tools, Market Uptake Strategy & Broader Outreach

In the galaxy of green energy alternatives, the project ICaRE4Farms has focused its efforts towards unveiling a new promising contender: next generation Solar Thermal Energy (STE) systems. However, speaking of a "newcomer" seems a bit overstated since this innovation has macerated for over 10

years, during which it has undergone changes, improvements & refinements. Before the project's start, around 30 Fengtech references were established, in a restricted perimeter embedding the Mayenne county & more widely the Pays de la Loire region. Nonetheless, this local market was sparsely covered with sites mainly applying STE to veal breading activities. In short, the early phase of next generation Fengtech STE roll-out was exclusively targeted on a local/regional basis, with really few exceptions in neighbouring territories (Brittany, Normandy, etc). Besides, it primarily equipped one specific type of agricultural domain rather than immediately explore the possibilities of other kind of farm holdings. If a cautious behaviour is accountable for this safe expansion strategy, one might note that until the project has begun, it took nearly 8 years for next generation STE systems to roll-out few installations in an infranational French territory …

This observation sheds light upon 2 main interconnected conclusions:

- *STE solutions are more than ever struggling to live up to its PV counterpart's prestige: 8 years for grasping barely 30 references on a very local, still sparse, basis does not* appears as a bad score; yet, it underlines how the road ahead remains long for green alternatives to be on par with its main rivals. Competition is biased because of the renown accumulated by PV over the years as the first long-standing sustainable energy for autonomous supply. Despite its potential & assets, STE systems must cope with few emphasis & appeals from customers, mainly because of its previously poor reputation in terms of efficiency & favourable conditions for installing.

- *A proper promotional support can unlock the door to greater consideration & an emerging success story:*
  via the ICaRE4Farms project, one much appreciated achievement corresponds to the strong impetus generated towards the celebrity & upscale of STE systems. Indeed, in approximatively 5 years, the company has more than doubled its prize by setting 50+ sites in France but also in a wider Europe: in early 2023, Fengtech launched its 2 first "foreign" references in the Flanders & in the Netherlands. Not only this uptake is limited to a geographical scope, it also broaden the range of sectoral applications in agriculture by implementing green hot water supply in Milk & Pig farm, for both direct consumption & building heating uses. This rewarding rise was accelerated thanks to the thorough support of the project team for promoting STE devices beyond.

To move from the former appalling situation to the latter more cheering results, 3 axes of development have been undertaken in the core of the project, in complementarity with previous & simultaneous mutually reinforcing actions:

❖ **Predicting the viability of an installation via a forecast toolbox:**

➢ *Developing a Feasibility Instrument for accurate & worthy installations: Prior any implementation, a diagnosis is necessary to ensure that the holding's characteristics are compatible with* an advantageous supply of STE. To do so, our Dutch partner CCS has elaborated a simulation tool, feeding on the numerical models & empirical results gathered by our scientific associates. It was designed to guarantee an optimal dimensioning of the plant & ruling out inadequate projects. Thanks to every data embedded & a standardised form to fill with specific settings, related to

local weather conditions & concrete applications, the tool is able to simulate via a user-friendly interface the heat demand, system size, buffer capacity required and potential savings, from which recommendations can be drawn. Since its release, this supporting instrument has been applied multiple times in real life scenario to broker new sites & optimise the main, complementary & additional project installations. Consecutive updates were carried out for upholding a quality assessment of applicant farms.

- *Selecting a web-based Monitoring Tool for constant oversight: This activity revolved around* seeking for an affordable & comprehensive instrument to oversee the plant operations in real time with key relevant information. After several interviews with experts & end-users, plus a set of answers to a qualitative questionnaire, exploring cost-related & functionalities aspects, it was decided to equip Pilot sites & willing "commercial" sites with the RESOL device. Indeed, it was discovered that among the many values to be indicated seamlessly, only the Temperature was deemed paramount to be displayed. Elements like CO2 reduction & Energy supplied were considered appealing but not mandatory since a comparison with energy bills prior to the installation would suffice to calculate the savings. However, for the sake of scientific measures, the tool encompasses anyway calculation of flow rates & in/outlet temperature. For each equipped installation, a web page can be browsed through & display in real time the solar irradiance & temperatures. It appears that aside from the project monitored pilot sites, few to no extra installation equipped with this device despite some alleged requests for real-time information.

- **Capitalising upon the existing references & supporting intermediaries:**

  - *Securing a faithful network of commited installors & distributors: For supplying one's device with a company growth perspective, it is mandatory at one point either to develop internally a dedicated department or* liaising at least with an extensive list of relevant & technical intermediaries. In the framework of the project, the second option was undertaken since promotion of the system performance & communication have been identified as the core elements for propelling STE solutions towards new highs. In that manner, a 2-step strategy has been tackled:
    - First, a reference list of potential installers/distributors has been filled in by each partner, so that it encompasses all 5 NWE partnering countries.This short-list was embedded only the 47+ most promising contacts in each country;
    - Secondly, the objective was to contact at least 30 companies out of these contacts to identify their interest in widening their product range with STE devices. In the event of positive reply, a questionnaire was solicited for better gauging their degree of potential commitment as "retailers". In case of negative or no answer, they were deemed unwilling to proceed further after one unsuccessful reminder.

It is interesting to note that this task demanded a lot of efforts with moderate outcomes because of the persistence of an entrenched reluctance that isolated promotions could not handle. Big successes were nonetheless achieved: 30 effective cooperations in France, a proposal for exclusive supply contract in Flanders, etc … Yet, scarce breakthroughs on this aspect occurred in the remaining partner countries.

- *Fostering a community of "trained" & educated stakeholders: Beyond installers & distributors, a large part of the project efforts* were directed towards the creation & entrenchment of a multi-stakeholder community, first connected via the project but meant to survive beyond this frame for improved STE deployment. This long-term strategy entails a set of diverse educational & communicational activities designed for grasping targeted types of key STE "promoters":
  - *Showcases & (Pilot) Site Visits:* speaking for itself, actions registered in this category were aiming at appealing to many types of stakeholders via disclosing a concrete outlook of STE installations & functioning. In total, more than 24 showcases occurred, with different distributions of attendees, in France, the Netherlands & Flanders. Remote/pre-recorded events occurred in Ireland & the UK.
  - *Training actions:* targeted mainly towards installers learning how to use the Feasibility tool, this task was widened to farmers & every party interested in mastering this simulation instrument & getting to know better specifications for next generation STE systems. A huge workload (nearly 40 trainings) was dedicated to this action & carried out with much impact especially in France, the UK & the Flanders.
  - *Info-day & dissemination events:* These actions were targeted at local medias & stakeholders; few events like the international SPACE convention in Rennes (2022 & 2023 editions) & Ouest France Congress for Agriculture in Laval from the famous French Newspaper attracted many targeted groups.
  - *Market Development Events:* Amongst all the events tackled, some occurrences engaged farmer associations & chambers of agriculture (or entities alike). For instance, active discussions have been nurtured with the NFU in the UK.
  - *Awareness-raising & Information campaigns:* aside from scientists, academicians & politicians, the last target group reached were local utilites & Renewable Energy Associations. 10 of them were successfully involved at different stages of the project, notably with the ADEME & Atlansun in France & Teagasc in Ireland.
  - *Associated Partners*: all the events organised or attended helped to engage new collaborators in the project, with this particular status; being an associated partner offer a privileged channel of information & a sufficient foothold in the project not to directly receive investments but for at least being able to promote & disseminate legitimately overall progresses &

achievements. In this circle 13 contacts are integrated: Communauté d'Agglomération du Cotentin (local authority / FR), deEnet (GERMANY), Teagasc (IE), Ebtech Glasshouse System (UK), Lincolnshire County Council (UK), Kamphuis Konstruktie BV (NE), ITAVI (Poultry Institute/FR), Oost NL (NE), Boerenbond (BE), GIE Elevage (FR), De Marke Innovation center (NE), IDELE (FR) & InAgro (BE).

According to estimates, taking into account two SPACE convention editions in R ennes & one EIP AGRI seminar, the project was disseminated to between 2000 & 5000 people, with various levels of commitment thereafter.

❖ **Securing a legacy & an entrenched dynamic of STE broad deployment:**

➢ *Constituting a Task Force of experts for supporting & widening the opportunities of roll-out:*
Beyond capitalising upon the existing sites, one core opportunity of the project was to set a Call for Application for both framing the readiness level of investment in each national market & selecting complementary sites for deepened promotion on the longer term. This extended roll-out strategy implied several stages:

- Setting a legitimate Selection Committee (composed with the Lead Partner, the Technology Supplier & the Feasibility Tool Developer)
- Formalising the selection criteria on an official documentation embedding guidelines for applying; it leads to the redaction of Terms of Reference enumerating the conditions of application
- Publication & Promotion of the Call for Application, with several communicational materials for ensuring its success
- Selection of the 17 award-winners: out of 48 applicants, 17 sites have been granted some advantages in the framework of the project
  - Free Feasibility Study
  - Extended Warranty (4 to 6 years)
  - Discount on material costs (10%)

It must be underlined that this activity set the basis for an exhaustive- & broader Task Force, dedicated to the deployment of STE solutions; indeed, beyond project partner, this group was meant to foster the legacy of the growing STE outreach propelled during ICaRE4Farms by widening its staff to the most interested stakeholders who joined their share of the overall efforts in the project's lifetime. It includes associated partners but also every company & entity supporting the uptake of STE technology. The mission is double: on one hand, providing assistance to end-users in the preparation of technical documents for STE systems in farms, helping to fine-tune the design support tools & make the technology better known; on the other hand, keeping an attentive eye at maintaining the I4F sites running for installers (5 years) & repairs materials available for Fengtech (10 years), in accordance with a Responsibility Agreement for long-term provisions.

- *Unlocking new channels of communication & market penetration: Last but not least*, this landscape of stakeholders is fully completed by inserting a key actor: political authorities & representatives. This step is crucial for generating changes & it is at the essence of the Policy Brief scope & objective. However, to retain their interests & seek a long-standing support, several initiatives are mobilised:
  - Invitations to Project's Events, like French MEP's intervention at the French Pilot Site Inauguration or specific Showcases in the Netherlands & Flanders
  - Tailored Visits dedicated to high-level representatives, like the French Minister of Europe
  - Intensive discussions with key political authorities, like the exchanges nurtured with NFU in the UK or Teagasc, SEAI & Ministry of Agricuture in Ireland
  - An NWE-wide Policy Webinar based on the Policy Brief highlighted findings & learnings, especially the 10 policy recommendations for better facilitate STE uptake & roll-out

Concretely, politicians represent a golden channel for both improving the visibility of one's initiative but above all they correspond to the main actor to inform, convince & help understnading the project better so that proactive commitment can be adopted to propel tangible & favourable shifts in the legislation. Their engagements & awareness about the necessary changes of regulations to apply for overcoming structural hinderances are paramount for enabling unprecedented evolution of habits.
That's where a complementary action, meant to link political advances & promotions with a strong group of diversified stakeholders acting at different levels, is inevitable: the constitution of a remote & European-wide community via digital tools. To do so, a LinkedIn page has been set to gather all information & active actors for STE uptake. It shares a dense content with both institutional & promotional websites. The latter was created in order uphold a durable legacy of the project's achievement while the I4F community of the social page ambitions to become the long-term reference group for pushing the project's objectives further.
This association of communicational manoeuvres was strategically designed to reach out, connect & provide a constant information to a growing & entrenched community of newly trained STE promoters.

To conclude, retaining a vast diversity of stakeholders has been one core point of the ICaRE4Farms initiative. It was a crucial objective to make sure that originality & quality of the STE solution was backed-up with an enduring & compelling outreach, through networking & promotion actions. Indeed, the key finding about the primary hardships faced by STE broader deployment relates to its lack of visibility & supporting channels for transcending the current market stalemate where the conditions developed all along this report have not been adapted for a performing & large-scale roll-out. The last following arguments will underline the complementary obstacles for STE to access its true & legitimate market potential.

b) Practical Hurdles in Rolling out beyond Boundaries

Until that point, competitivity of STE solutions has been tackled under 2 main aspects: on one hand, its alternative dimension; on the other hand, its high performance. Beyond these characteristics relating to an emerging innovative energy supply, a third prominent point is also to detail: market readiness for STE technology penetration. Precisely, 2 main observations must be differentiated:

- Internal Adverse Legislation prevents a benevolent widespread deployment in native & foreign NWE markets
- Insufficient education about relevant alternatives sources of renewable energy

These intertwined problematics have been the marking point for dampened spreading of STE solutions, along with the company's limited capacities. However, as significantly pointed out at multiple times during this extensive review, modest resourcing should not be a reason for market exclusion & supporting schemes must be more largely unfolded to accompanying promising innovation, in all its diversity & situation. More than ever, these issues remind how much a willing political impetus can solve many pitfalls & it displays the key role of political officials in arranging a favourable legislative environment for innovative enterprises & ideas to thrive.

Those reflections can be grasped under 3 primary challenges to overcome:

(i) A regulatory framework poorly inclined to the emergence of Green Alternatives

The ICaRE4Farms project endeavoured to deploy, experiment & showcase results from 4 Pilot Sites & replicate those objectives on additional installations, distributed over the 5 partnering countries, namely France, UK, Netherlands, Belgium (Flanders) & Ireland. In its whole lifetime, this major task has been successfully achieved but it encompassed several difficulties endangering its full completion. Indeed, over the 5 covered territories, only 3 regions have installed operational references. Amongst the 3 equipped national grounds, 3 scenarii have been encountered where STE systems have been diversely dampened in their roll-out:

- FRANCE
  - In its native country, the Fengtech next generation STE systems spent 10 years & one EU project to become a major actor of the Energy domain; yet, despite 80+ sites nowadays & a broader territorial coverage, the company's size is alleviating its potential of deployment
  - Furthermore, certifications & access to the correlated support schemes to be awarded have exposed a structural flaw in the French subsidy framework that downsized the technology outreach & endangered its mere survival: the lack of available, rather accessible, fundings nurtured a statu quo were liberal SME inventors could not cope with bigger competitors, benefitting from significant subsidy "discounts"
  - Nevertheless, not only one but two Pilot Sites were started from scratch, excluding also the pre-audit installation in Brittany; those plants enabled to obtain measurements on the two categories of STE main applications, namely direct consumption & building heating, via the cases of calf & pig farm

- This success exposes with a peculiar lucidity the pivotal importance of public fundings in supporting green energy projects: both the French Pilot Sites were quickly agreed & install BECAUSE of the special ICaRE4Farms subsidy, with 60% of expenses covered If such a scale of public investments is obviously not viable on a systematic basis, it sheds light upon the current carence at a lower level of benefitted funds.

- NETHERLANDS
  - In one out of the two « adopting countries », STE systems has faced another kind of restrictions with a fiercer impact than elsewhere : permit buildings
  - In the Netherlands, due to the « De Zonneladder » regulation & the land limits compared to bigger countries like France or the UK, a construction is confronted with different types of administrative steps, depending on the qualification of the chosen grounds
  - Hence, 4 categories exist : from industrial & peripheral grounds to viable & agricultural soils, the most viable for the harvesting activities, the harder to get the permit.
  - In that context, the Dutch Pilot site struggled to take-off due to consecutive & heavy administative procedures, culminating in a moment of uncertainty for the fate of this installation, planned to cover fertile farming lands from an experimental agricultural holding ; fortunately, this important delay was downplayed by the the effective settup of the plant

- FLANDERS
  - In this second region of import, STE systems were faced with a combination of the 2 previous case scenarii : the permit building process demanded to re-plant 6 trees for the 2 ones that had to be cut down for the installation to be properly operational & the approval could only be reached thanks to the available project grant
  - In comparison, among the 5 candidates selected for becoming the Flemish Pilot, the 4 unsuccessful applicants never furthered their interest in equipping with STE systems, once subsidy opportunity was no longer available
  - Still, the project's efforts through communicational actions among other things, enabled the technology to widen its outreach: a contract has even been proposed by the owner of the Flemish site for exclusive distribution in Belgium & 3 years as intermediate checkpoint for roll-out in Turkey
  - Above all, it was insightful of the current state for competition in the Innovation Market : the risk is not sufficiently assisted via public funds, leading the end-user/customer themselves to support emerging solutions with an adventurous bet

(ii) A deficient provision of awareness-raising initiatives

If early-phase customers are left by public schemes with investing for a new innovative technology & carrying the risks of hox or failure, these improvised promoters disclose a striking reality : access to a transparent information offers enough insights for considering taking the risk as a supporter. In other words, educational actions appear as a key vector for spreading more knowledge with transparency & convince potential end-users to test the solution. When looking back at the early stage of Fengtech next generation STE systems, it has to be noted that every equipment sales relied on interpersonnal

promotions, from one satisfied customer to one another. It took 10 years for the company to secure a viable market in the West of France, plus few addition in the rest of the country; it would at least demand a similar timing for most of the NWE territories, without proper underpinnings.

That's why, part of the ICaRE4Farms initiative, revolved around liaising with high-profile representatives & key stakeholders to communicate them every valuable piece of compelling information for the device's successful roll-out.
If this endeavour paved the way towards a more visible outreach in most of the partnering countries, this legacy requires sustained efforts on the longer term; however, at this multinational scale, except the ICaRE4Farms project & its spin-off actions to be uphold after its ending, awareness-raising campaigns towards the uptake of STE systems are inexistent. A shift occurred with ICaRE4Farms since localised & punctual trainings programmes were organised: Innov'actions week from the Chamber of Agriculture Pays de Loire, with even a special edition in 2023 entirely dedicated to solar thermal energy; specific info-days were led by Boerenbond in Flanders & an extensive network of NFU members were reached out in the UK.

If these thorough actions have triggered a tangible change for STE renown, some dangers will be still looming once the project will be halted:

- Continuation of a dynamic STE community is eventually not ensured since, deprived with the main I4F coordinators, substitute actors selected on a basis of relevant stakeholders & institutions give few certitudes about maintaining a satisfying level of promotions & communication & no one can tell whether they would end up siding with a new solution or avoid risks by supporting rather safe & classic solutions like new generation PV for instance.
- Concrete field actions will certainly slow down because of the lesser commitment of project partners in nurturing these dynamics after the project, due to no more available fundings for pursuing on their own their inheritance; yet, institutions like the Chamber of Agriculture Pays de la Loire will certainly organise few visits or events in the future while UBS & Fengtech have already secured a new national CIFRE thesis for furthering the project's scientific learnings

Once more, this concrete example stresses the prominence of subsidy fundings in unlocking new pathways of consumption habits & lifestyle. Green transition needs innovation & renown but to do so it definitively necessitates to strive for investments to properly & efficiently roll-out.

(iii) A non-systematic & suitable support programme for Green Transition companies

An ultimate point for this brief to be developped will focus upon an aspect a bit overlooked until now: company's behaviour influence on the long-term roll-out strategy.
Indeed, a proper market penetration entails 3 elements: an offer (performance & technical aspect), a demand (the public/customer dimension) & the in-between connection to consistently link the commercial relation, namely the strategy! Of course, it is up to each company's leader to decide how to conduct their business & several tactics exist for nurturing success, in diverse forms. For the Fengtech company, due to limited resources & staff (two members, including the CEO & the salesman until early 2023), has always opted for a prudent strategy of expansion & roll-out: few supply ordered & stocked, depending on the effective contracts encountered, no sale if the system is considered not satisfying for the dimensioning of the holding or the activity (in order to maintain a professional &

virtuous reputation), a very local/regional target market until the start of the I4F project, etc. This tactic has enabled the company to relatively thrive, at least sustain its growth, even if it has to be at slow pace. Thus, these different aforementioned factors explain progressive development of the enterprise over 10 years ; however, it does not take into consideration fully the role played by the project's impetus in broadening the STE solution produced by the company to an enhanced outreach.

Moreover, it overshadows the involvement of LMT, coordinator of the project but especially the institution responsible for Fengtech incubation, at an earlier stage, when it was a start-up. Without the efforts for supporting this company's emergence, other strategies might have been chosen & perhaps would have led next generation STE systems to never boom, or worst, be burried amongst the forgotten innovations that never met success. If caution was a way amongst others for running a viable market strategy, a quicker rise might have also occurred by taking more risks … or by upskilling & upscaling the support programme beyond the Start-up schemes. Indeed, despite a second range of assistance designed for SMEs, Fengtech never subscribed to this advanced programme from LMT & rather chose, some years after to skip directly to the third supporting scheme, relating to networking & collaboration projects.

If it is not the goal (or even necessary) to assign the "guilt" of an "uncomplete" business training to either Fengtech or LMT, this example depicts two conclusions:

- Business support programmes towards any kind of companies, and in this case especially for Green transition or even disruptive & innovative products at stake with the contemporary societal shifts, are an inevitable blessing for fostering the market & economy health while raising awareness for just causes
- These incubation & acceleration programmes are not targeting enough this specific category of enterprises: for instance, over the hundreds & hundreds of applications over the years, Fengtech is one, if the not only company supported by LMT, that focus on energy transition & agriculture, that survived as a start-up & grow beyond this status.

These observations invite to reflect on how this success rate might be improved while taking into consideration endogenous (resilience of the start-uppers motives, will & innovation) & exogenous (very competitive market conditions) factors.

As a general conclusion for this Part II, it is more than ever important to frame the challenges faced by STE deployement in a weather & renown-adverse NWE environment. If 3 learnings had be remembered, one must note that achieving an innovative technology roll-out entails to provide a sustainable alternative that can stand with its competitors thanks to its applications, its performance & its renown. For all these aspects, a specific emphasis on communication & promotion, under several medias & channels, are key for its consecration.
In the Part III of this Policy Brief, it will now be time to estimate the possible remedies to enforce in order to correct the current hinderances to a blossoming innovation.