CASE STUDY

I4F-WP1-Task 3

Context/Intro:

In the framework of the ICaRE4Farms project, this document aims at reviewing the theoretical inner potential of Feng Tech STE system within the agricultural sector of greenhouses.
The current academic example focus on a holding specialised in market gardening and set in Haut-de-France.
The assumptions are that it owns a surface of 1 hectare for which it needs around 2 403 692 kWh of energy supply per year in order to heat the greenhouse.
After enumerating the main characteristics of this typical and fictional greenhouse, a simulation with the Feng Tech STE system illustrating expected results will be tackled.
This file will be completed and crossed with a real-life case with similar attributes.

!!!!invent for academic/anonymise for field application case!!!!!

PART I: ACADEMIC CASE

- *N°/Nickname:* N°3 / French Greenhouses
- *Location (Country/Region):* Haut-de-France
- *Type of holding:* Market Gardening
- *Date:* 20/09/2021

1 Initial characteristics of the installation: (Use Market Analysis + Technology Assessment)

- **Size of the surface:** 10000 m2 (1 hectare)
- **Type of production:** Tomatoes
  [Placing photos of the structures and equipment]
- **Water Use (frequency, quantity, timeframe, etc):** Heating of the greenhouse
- **Frequency***:* All year round (especially during cold period like winter)
- **Daily Heating Consumption:** in average, 2 to 3 GWh/year = 2 000 000 - 3 000 000 kWh/year (for 1 hectare) => 2.10^6 / 365 = **5479,5 kWh/day**
- **Version of FT STE system**: ETF 2 (version with pressure)
- **Temperature needed (in °):** 50°C
- **Standard fossil energy used:** Natural gas
- **Price per kWh:** *0.045 EXCL. TAX/€/kWh*
- **Energy consumption for the activity (in kWh):** 2 403 692 *kWh/year*
  cf.with energy waste and differentiated needs depending on the period of the year, the energy need accounts for 2 403 692 kWh/year
- **Expenditure of energy consumption (in €/kWh):** 108 166.14 *€ EXCL. TAX/year*
  cf. 0.045 EXCL.TAX/€/kWh x 2 403 692 kWh/year = 108 166.14 EXCL. TAX €/year
- **Available subsidies for STE:** between 20 and 40% of the equipment cost (*Fonds Chaleur*)
- **Amount of CO2 emission:** 475 931 *kg CO2/year*
  cf. given that 1kWh produces about 0.198kg CO2(eq), 0.198kg CO2/kWh x 2 403 692 kWh/year = 475 931 kg CO2/year

Prerequisites of installation:

- Located on floor or roof
- Preference = South-West facing
- Not far from the holding to avoid additional energy needs for re-heating

Employed Version of the matrix = V9 Brest Study Case / Irradiance & Cold Water from V11 Lilles

2 Simulation with a Feng Tech STE system:

- **Coverage Rate of the installation (Share of utilisation in %):** 50% at least - HERE = 50%
  cf. precising when the farmer wanted willingly a restricted share of power supply + Depending on location and weather + the value is imposed as it is the hypothetical reference we want to check after with the field application case

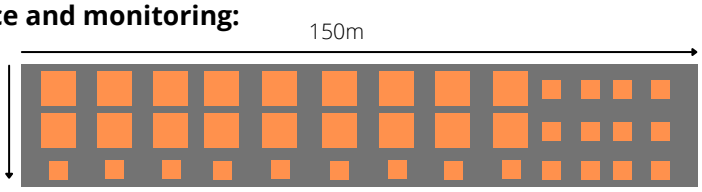
- **Number of STE units to reach the energy needs:** 250 units
  cf. potential energy savings = 1 192 611 kWh/year

- **Overall front surface of capture:** 1000 m2
  cf.1 FT = 4m2 ; 4m2/unit x 250 units = 1000 m2

- **Maximum attainable temperature with the current solution (in °):** 100°T (optimal conditions)

- **Power (kW/unit):** 2.5kW/unit

- **Number of sensors needed for remote surveillance and monitoring:**
  Commercial scope = 2 thermometers + 2 flowmeters



- **Surface requirement for the equipment:**
  cf. Length of concrete slab = size of panels (2x2m) + space between panels (1m x t panels) / Width = 3 m

Solar irradiance value (Calsol INES)	Lille 45°	Albedo	0,8										
Unit (kWh / m² / day)	January	February	March	April	May	June	July	August	September	October	November	Décember	Year
Direct irradiance	0,57	0,96	1,61	2,11	2,21	2,36	2,13	2,11	2,05	1,43	0,72	0,45	1,56
Diffus irradiance	0,45	0,79	1,29	1,87	2,29	2,49	2,4	2,05	1,53	0,97	0,54	0,36	1,42
Cold water temperature (°C)	6,2	6,5	8,1	9,5	11	13	14	14	13	10	8,1	6,7	10

- **Solar energy contribution (in kWh)**: 1 192 611 *kWh/year*

  - Yearly Basis: 250 FT STE units' full potential = **1 192 611 kWh/year** *(relating to a specific simulation case)*
    cf. it corresponds to 775 197 kWh/year useful solar energy (depends on distance, insulation etc. / simulation from an average case)
  - Daily Basis: 1 192 611 kWh/year / 365 days = **3267.43 kWh/day**

- **Savings on energy consumption (in €)**: 53 667.5 *€ EXCL. TAX/year*
  cf. Given that, with energy waste and depending on the period of the year,
  the energy saving accounts for 1 192 611 kWh/year x 0.045€/kWh = 53 667.5 €/year

- **Remaining share of the standard energy used (per year):** 54 498.6 *€/year* **(**50% ; 1 211 081 kWh/year)

  - In %: solar thermal energy represents 50% here so, remaining share of **50%**
  - In kWh: 2 403 692 - 1 192 611 = **1 211 081 kWh/year**
  - In €: 1 211 081 kWh/year x 0.045 €/kWh = **54 498.6 €/year**

- **Remaining emission of CO2:** 239 794 *kg CO2 (CO2 reduction up to 236 137 kg CO2)*
  cf. 1 211 081 kwh/year x 0.198kg CO2 = 239 794 kg CO2

WITH AIDS

- **Previsionnal Cost (total - subsidies):** 568 750 €

  cf. cost of equipment & installation + site preparation - potential aids = previsional cost

  - **Cost of the equipment & installation:** 875 000€

    Notes: 3829€ for one stainless steel unit & 3480€ for one basic unit + installation expenses = 4000€/unit / 250 units x 4000€/unit = 875 000€
  - **Cost of the site preparation:** 4000€

    cf. *in average if not done personally by the holder*
  - **Aids and subsidies available:** *306 250 €*

    cf. average grant = 35% ; 875 000 x 0.35 = 306 250 € *in the event of approval by regulating authorities*

    OPTIONAL COST: *monitoring = 1200€ (equipment) + 1200€ (installation)+ 38 €/year (RESOL subscription)*

- **Financial Package : 56 875** *€/year for 10 years* (in average)

  cf. Total - subsidies ; cash + financial loan (= duration + annuity)
  - Previsionnal cost = financial loan = **568 750 €**
  - Duration: **10 years** / Loan rate = **1.50%** (with yearly increase) / STE Durability = **+30 years**

    => 568 750 € / 10 years = 56 875 €/year ; taking into account the loan rate: **61 283 €/year** (in average)

- **Return on investment (global expense / annual savings):** 10 *years & 7 months*
  - Global expense = **568 750 €**
  - Annual energy savings = **53 667.5 € per year** during 30 years so in total : 53 667.5 €/year x 30 years = **1 610 025 €**
  - ROI = 568 750 € / 53 667.5 € = **10 years & 7 months**
  - ROIC = 53 667.5 / 568 750 € = **9.4 %**

- **Yearly Earnings (Annual savings and yearly loan payment):** - *7615.5 €/year (*1st year) then 53667.5 €/year

  cf. good if savings > loan
  - Annual savings = **53 667.5 €**
  - Yearly loan payment = **61 283 €**
  - Difference = 53 667.5 - 61 283 = **- 7615.5 €/year of earnings during the 10 year-loan period / after = 53 667.5 €/year**

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Costs without STE	4847	5089	5344	5611	5891	6186	6495	6820	7161	7519	7895	8290	8704	9140	9597	10076	10580	11109	11665	12248
Loan repayment	4310	4310	4310	4310	4310	4310	4310	4310	4310	4310	0	0	0	0	0	0	0	0	0	0
Gas remaining to buy	2138	2245	2357	2475	2599	2729	2865	3009	3159	3317	3483	3657	3840	4032	4233	4445	4667	4901	5146	5403
System maintenance	0	0	0	0	0	200	206	212	219	225	232	239	246	253	261	269	277	285	294	303
Costs with STE	6448	6555	6667	6785	6909	7239	7381	7531	7688	7852	3715	3896	4086	4285	4494	4714	4944	5186	5439	5706
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy saving (1-5) €HT/Y	-1601	-1466	-1324	-1174	-1017	-1053	-886	-711	-526	-333	4180	4394	4619	4854	5102	5363	5636	5923	6225	6542
Energy saving €HT/m	-133	-122	-110	-98	-85	-88	-74	-59	-44	-28	348	366	385	405	425	447	470	494	519	545

- **Network of installers:** Ets LEFORT / Solair3Tech / Elevance (groupe Agriale) / Pineau Thermic System / MAES Ets / Lacta Services / INOVIA (Ancien du Groupe Terrena) / SARL TESSIER / Comptoir machine à traire (CMT) / CES Tardy - EMERAUDE ELEVAGE EQUIPEMENT / Energies libres

- **Legislation for installation/Procedures and precautions:** rural environnment so few restrictions ; when roof, request for work to municipality / when on the floor, nothing needed as long as within property

RELEVANT REMARKS & COMMENTS

NB 1: what about simulating another model where only the service of energy is sold, not the device?

NB 2: is Liqun a subcontractor of the installers or reverse?

NB 3: for each set of case study (academic + field application), making a review of conclusions (approximatively 1p)

CASE STUDY

I4F-WP1-Task 3

NO AIDS

- **Previsionnal Cost (total - subsidies): 879 000** *€*

  cf. cost of equipment & installation + site preparation - potential aids = previsional cost

  - **Cost of the equipment & installation:** 875 000*€*

    Notes: 3829€ for one stainless steel unit & 3480€ for one basic unit + installation expenses = 4000€/unit / 250 units x 4000€/unit = 875 000€
  - **Cost of the site preparation:** 4000*€*

    cf. *in average if not done personally by the holder*
  - **Aids and subsidies available:** *0€*

    cf. average grant = 35% *in the event of approval by regulating authorities*

    OPTIONAL COST: *monitoring = 1200€ (equipment) + 1200€ (installation)+ 38 €/year (RESOL subscription)*

- **Financial Package :** 153 203 *€/year for 10 years* (in average)

  cf. Total - subsidies ; cash + financial loan (= duration + annuity)
  - Previsionnal cost = financial loan = **879 000 €**
  - Duration: **10 years** / Loan rate = **1.50%** (with yearly increase) / STE Durability = **+30 years**

    => 879 000 € / 10 years = 87 900 €/year ; taking into account the loan rate: **94 712 €/year** (in average)

- **Return on investment (global expense / annual savings):** 16 *years & 4 months*
  - Global expense = **879 000 €**
  - Annual energy savings = **53 667.5 € per year** during 30 years so in total : 53 667.5 €/year x 30 years = **1 610 025 €**
  - ROI = 879 000 € / 53 667.5 € = **16 years & 4 months**
  - ROIC = 53 667.5 / 879 000 € = **6.1 %**

- **Yearly Earnings (Annual savings and yearly loan payment):** - *41 044.5 €/year* for 1st year, then 53 667.5€/year

  cf. good if savings > loan
  - Annual savings = **53 667.5 €**
  - Yearly loan payment = **94 712 €**
  - Difference = 53 667.5 - 94 712 = **- 41 044.5 €/year of earnings during the 10 year-loan period / after = 53 667.5 €/year**

Année	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Charge sans solaire	108166	115738	123839	132508	141784	151709	162328	173691	185850	198859	212779	227674	243611	260664	278910	298434	319324	341677	365594	391186
Remboursement emprunt	94712	94712	94712	94712	94712	94712	94712	94712	94712	94712	0	0	0	0	0	0	0	0	0	0
Gaz restant à acheter	54499	58314	62395	66763	71437	76437	81788	87513	93639	100194	107207	114712	122741	131333	140527	150363	160889	172151	184202	197096
Entretien du système	0	0	0	0	0	200	206	212	219	225	232	239	246	253	261	269	277	285	294	303
Charge avec solaire (2+3+4)	149211	153026	157108	161475	166149	171349	176706	182437	188569	195131	107439	114950	122987	131587	140788	150632	161166	172436	184495	197398
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eco d'énergie (1-5) €HT/an	-41045	-37288	-33268	-28967	-24365	-19641	-14378	-8746	-2720	3728	105340	112723	120624	129077	138123	147802	158158	169241	181099	193788
Eco d'énergie €HT /mois	-3420	-3107	-2772	-2414	-2030	-1637	-1198	-729	-227	311	8778	9394	10052	10756	11510	12317	13180	14103	15092	16149

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1 Initial characteristics of the installation: (Use Market Analysis + Technology Assessment)

- **Size of the surface:** 10000 m2 (1 hectare)
- **Type of production:** Tomatoes
  [Placing photos of the structures and equipment]
- **Water Use (frequency, quantity, timeframe, etc):** Heating of the greenhouse
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- **Daily Heating Consumption:** in average, 2 to 3 GWh/year = 2 000 000 - 3 000 000 kWh/year (for 1 hectare) => 2.10^6 / 365 = **5479,5 kWh/day**
- **Version of FT STE system**: ETF 2 (version with pressure)
- **Temperature needed (in °):** 50°C
- **Standard fossil energy used:** Natural gas
- **Price per kWh:** *0.045 EXCL. TAX/€/kWh*
- **Energy consumption for the activity (in kWh):** 2 403 692 *kWh/year*
  cf.with energy waste and differentiated needs depending on the period of the year, the energy need accounts for 2 403 692 kWh/year
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Prerequisites of installation:

- Located on floor or roof
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Employed Version of the matrix = V9 Brest Study Case / Irradiance & Cold Water from V11 Lilles

2 Simulation with a Feng Tech STE system:

- **Coverage Rate of the installation (Share of utilisation in %):** 50% at least - HERE = 50%
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- **Number of STE units to reach the energy needs:** 250 units
  cf. potential energy savings = 1 192 611 kWh/year

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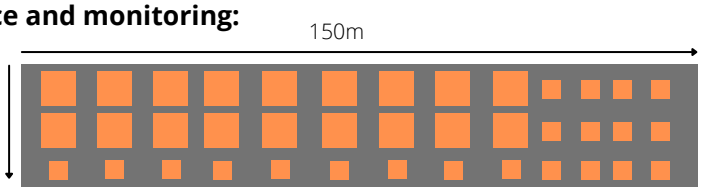
  cf.1 FT = 4m2 ; 4m2/unit x 250 units = 1000 m2

- **Maximum attainable temperature with the current solution (in °):** 100°T (optimal conditions)

- **Power (kW/unit):** 2.5kW/unit

- **Number of sensors needed for remote surveillance and monitoring:**
  Commercial scope = 2 thermometers + 2 flowmeters



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  cf. Length of concrete slab = size of panels (2x2m) + space between panels (1m x t panels) / Width = 3 m

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Cold water temperature (°C)	6,2	6,5	8,1	9,5	11	13	14	14	13	10	8,1	6,7	10

- **Solar energy contribution (in kWh)**: 1 192 611 *kWh/year*

  - Yearly Basis: 250 FT STE units' full potential = **1 192 611 kWh/year** *(relating to a specific simulation case)*
    cf. it corresponds to 775 197 kWh/year useful solar energy (depends on distance, insulation etc. / simulation from an average case)
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- **Remaining share of the standard energy used (per year):** 54 498.6 *€/year* **(**50% ; 1 211 081 kWh/year)

  - In %: solar thermal energy represents 50% here so, remaining share of **50%**
  - In kWh: 2 403 692 - 1 192 611 = **1 211 081 kWh/year**
  - In €: 1 211 081 kWh/year x 0.045 €/kWh = **54 498.6 €/year**

- **Remaining emission of CO2:** 239 794 *kg CO2 (CO2 reduction up to 236 137 kg CO2)*
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WITH AIDS

- **Previsionnal Cost (total - subsidies):** 568 750 €

  cf. cost of equipment & installation + site preparation - potential aids = previsional cost

  - **Cost of the equipment & installation:** 875 000€

    Notes: 3829€ for one stainless steel unit & 3480€ for one basic unit + installation expenses = 4000€/unit / 250 units x 4000€/unit = 875 000€
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    cf. average grant = 35% ; 875 000 x 0.35 = 306 250 € *in the event of approval by regulating authorities*

    OPTIONAL COST: *monitoring = 1200€ (equipment) + 1200€ (installation)+ 38 €/year (RESOL subscription)*

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  cf. Total - subsidies ; cash + financial loan (= duration + annuity)
  - Previsionnal cost = financial loan = **568 750 €**
  - Duration: **10 years** / Loan rate = **1.50%** (with yearly increase) / STE Durability = **+30 years**

    => 568 750 € / 10 years = 56 875 €/year ; taking into account the loan rate: **61 283 €/year** (in average)

- **Return on investment (global expense / annual savings):** 10 *years & 7 months*
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Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Costs without STE	4847	5089	5344	5611	5891	6186	6495	6820	7161	7519	7895	8290	8704	9140	9597	10076	10580	11109	11665	12248
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- **Legislation for installation/Procedures and precautions:** rural environnment so few restrictions ; when roof, request for work to municipality / when on the floor, nothing needed as long as within property

RELEVANT REMARKS & COMMENTS

NB 1: what about simulating another model where only the service of energy is sold, not the device?

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NO AIDS

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  - ROI = 879 000 € / 53 667.5 € = **16 years & 4 months**
  - ROIC = 53 667.5 / 879 000 € = **6.1 %**

- **Yearly Earnings (Annual savings and yearly loan payment):** - *41 044.5 €/year* for 1st year, then 53 667.5€/year

  cf. good if savings > loan
  - Annual savings = **53 667.5 €**
  - Yearly loan payment = **94 712 €**
  - Difference = 53 667.5 - 94 712 = **- 41 044.5 €/year of earnings during the 10 year-loan period / after = 53 667.5 €/year**

Année	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Charge sans solaire	108166	115738	123839	132508	141784	151709	162328	173691	185850	198859	212779	227674	243611	260664	278910	298434	319324	341677	365594	391186
Remboursement emprunt	94712	94712	94712	94712	94712	94712	94712	94712	94712	94712	0	0	0	0	0	0	0	0	0	0
Gaz restant à acheter	54499	58314	62395	66763	71437	76437	81788	87513	93639	100194	107207	114712	122741	131333	140527	150363	160889	172151	184202	197096
Entretien du système	0	0	0	0	0	200	206	212	219	225	232	239	246	253	261	269	277	285	294	303
Charge avec solaire (2+3+4)	149211	153026	157108	161475	166149	171349	176706	182437	188569	195131	107439	114950	122987	131587	140788	150632	161166	172436	184495	197398
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eco d'énergie (1-5) €HT/an	-41045	-37288	-33268	-28967	-24365	-19641	-14378	-8746	-2720	3728	105340	112723	120624	129077	138123	147802	158158	169241	181099	193788
Eco d'énergie €HT /mois	-3420	-3107	-2772	-2414	-2030	-1637	-1198	-729	-227	311	8778	9394	10052	10756	11510	12317	13180	14103	15092	16149

- **Network of installers:** Ets LEFORT / Solair3Tech / Elevance (groupe Agriale) / Pineau Thermic System / MAES Ets / Lacta Services / INOVIA (Ancien du Groupe Terrena) / SARL TESSIER / Comptoir machine à traire (CMT) / CES Tardy - EMERAUDE ELEVAGE EQUIPEMENT / Energies libres

- **Legislation for installation/Procedures and precautions:** rural environnment so few restrictions ; when roof, request for work to municipality / when on the floor, nothing needed as long as within property

RELEVANT REMARKS & COMMENTS

NB 1: what about simulating another model where only the service of energy is sold, not the device?

NB 2: is Liqun a subcontractor of the installers or reverse?

NB 3: for each set of case study (academic + field application), making a review of conclusions (approximatively 1p)