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The Urban Lab of Europe !

The FED project
Journal N° 5

*Project led by the **City of Gothenburg***

ENERGY
TRANSITION

European Union
European Regional
Development Fund

Région
Hauts-de-France

The FED project

With this project, the city of Gothenburg aims to develop, demonstrate and replicate a novel district level energy system, integrating electric power, as well as heating and cooling. This solution embraces and enhances the use of technologies such as PVs, heat-pumps and energy storage into a larger system. To overcome the main challenges, the proposed solution contains advancements in system development and operation, business logistics, legal framework as well as stakeholders' acceptance.

The FED solution consists of three cornerstones:

FED demonstrator area – The selected demonstration is located at a campus with about 15 000 end-users. It has a well-balanced set of property owners, energy infrastructure, and users, including prosumers as well as buildings with different needs and usage profiles. The area is exempted from the law of concession for electricity distribution, providing the opportunity to test and validate a local energy market. The prerequisites to optimize the use of primary and secondary energy using intermediate storage are well developed, as they are for generation, storage and distribution.

FED System solution – Our solution will optimise the use of low-grade energy to replace primary energy. Adding fossil-free energy sources while optimising different buildings usage profiles; one building's energy needs will be balanced with the surplus of another. Intermediate storage, fundamental to be a success, consists of heating storage in the building's structure, an innovative cooling storage using phase changing material and batteries for electricity. An ICT service will host the local market and provide the connection to the outside world of spot prices and weather forecasts. The smart agents connect and trade within the system that provides the flexibility to support future volatile energy markets

FED Business solution – Create new sustainable markets. The success of FED depends on cooperation and energy exchange between several stakeholders. To make it happen, a local energy market creating business value for each stakeholder will be developed.

Partnership:

- Göteborg Stad – City of Gothenburg
- Johanneberg Science Park AB - Public/Private Company
- Göteborg Energi AB - Public Company / Local energy utility
- Business Region Göteborg AB - Public Company for business support
- Chalmersfastigheter AB - Private Company and local property owner
- Akademiska hus AB - Private Company, national property owner
- Chalmers University of Technology - Academia
- RISE - Research Institute
- Ericsson AB - Private Company in ICT

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1. Executive Summary

This fifth journal on the FED project in Gothenburg includes the end of the project and is written after a visit to the slot-event in Brussels in the autumn of 2019[1].

In the meantime, at the Chalmers campus in Gothenburg, the 6500 kW steam boiler was installed, as well as the more novel PCM (Phase Change Material) storage and Li-Ion batteries – all nicely in time. These were the last components to complete under the FED contract. So in fact, all foreseen technical hardware is installed and functioning now.

So, in three years' time the FED project has developed a **local energy system** and a local, digital **marketplace** with three energy carriers: electricity, district heating and district cooling. It optimizes use of energy storages.

The FED upscaling strategies are not fully analysed in this journal yet, but some of the preliminary work is here. The new hardware produces sustainable energy and in good amounts. (Certainly in Swedish hottest summer ever in 2018). As highlighted earlier, the financial sustainability and upscaling are topics that are among the pre-identified challenges by the UIA and they are still there. The content of the final Journal, number 6, in the autumn of 2020 will supply more information on that as well as on the evaluation & monitoring results.

Finally, the policy recommendations from the FED project can be used for a good discussion on the challenges UIA introduced in 2016, and touch on high-level EU policy-elements as well as local ones. For the full overview, please see the FED's own booklet[2].

1 https://www.linkedin.com/posts/johanneberg-science-park-ab_celsius-summit-2019-activity-6595614084295643137-q3tR
2 https://www.johannebergsciencepark.com/sites/default/files/FED_boken_uppslag_0.pdf

2. Final technical project implementation update

What happened when the project finished in October 2019?

The short story is, nothing happened. The FED market place kept on running like it had been running since the beginning of the year. The system just grew in 2019, basically exactly like planned even before 2017 with 24 consuming buildings and 11 prosumers. Prosumers being buildings that consume and produce heat, cooling or electricity. The two buildings that host the biofuelled heat production stayed in production and the 16 storage installations, among which PCM-storage and Li-Ion batteries kept storing. Never stand alone, as that was not the meaning of the FED project. The figure underneath gives an overview of the system embedded in the Gothenburg Energi system.

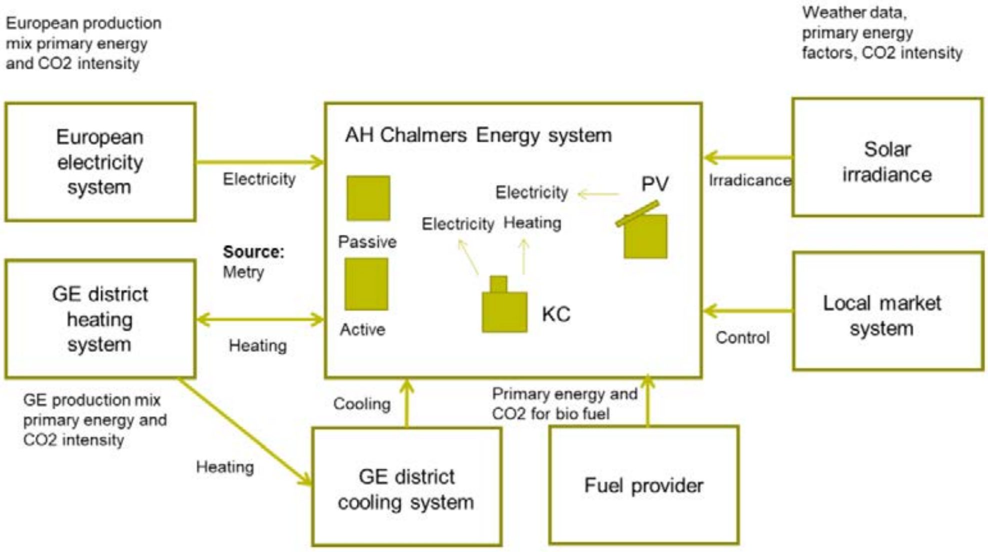

Figure 1: conceptual diagram of the energy flows between the external system and the FED system. (GE = Gothenburg Energi, the local energy supplier)

Overview of the technical system

Of course, most of the units were in place before the FED project started. FED added more than production and storage capacity, it developed a system for trade and with that, created a testbed and it formulated replication strategies. From the viewpoint of the UIA, it took on urban challenges, brought down local barriers and was one of the first UIA projects to be delivered. This chapter however should provide an overview of the technical delivery, both for the production and storage and for the marketplace. This is best done with the use of two figures.

The first figure should be familiar now for readers of the FED journals and it shows the Chalmers Campus with little number. The numbers represent specific installations that are listed in the table under the figure. This reports includes the final updated figure, with the storage capacities (11, 12 & 13) no longer in planning, but finally installed and active now.

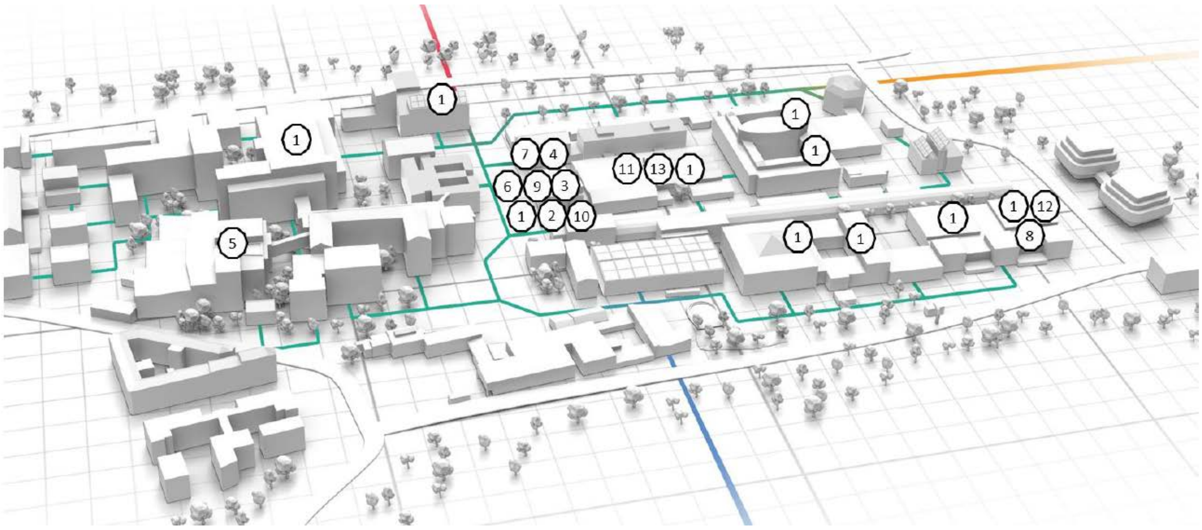

Figure 2: Completed infrastructure of the FED system, buildings that 'only' consume are visible, but not listed.

Notes to figure 4-8:

1. Solar PV Modules, O7:23 SB2, O7:26 SB1, O7:8 KC, O7:17 Bibliotek, O7:44 AWL, O7:27 SB3, O7:28 Maskin, O7:20 Elkraft, O7:11 Elkraft and Kemi – connected to IKN network.
2. Boiler 1, KC – connected to VP01 network.
3. Absorption Chillers, KC producing cooling – connected to KB0 network.
4. Heating and Cooling Pumps (O7:28 VKA1, O7:8 VKA4) producing heating and cooling, KC – connected to KB0 and VP01 networks.
5. Chiller system, MC2 – connected to KB0 network.
6. District heating connection from public network to VP01.
7. Electric power connection from public network to IKN networks.
8. Battery Storage, AWL –connected to IKN network.
9. Heating and cooling pump (8-VKA2), KC – connected to VP01 and KB0 network.
10. Steam Boiler 2 and Steam Turbine, KC, used for production of heat and electric power - connected to VP01 and IKN network respectively.
11. Quick-Charging Battery storage, O7.28 Maskin –connected to IKN network.
12. PCM Cooling Storage, AWL – connected to KB0 network.
13. Cooling storage tank, O7:28 Maskin – connected to KB0 network.

The FED Market system

The second picture is the one that shows the full market design of the FED. It hasn't changed much, as it is conceptual of course, but is has now been proven to work. From the viewpoint of the FED picture the listed storages, buildings, production units are all market players, that need to be handled via the agents in the market.

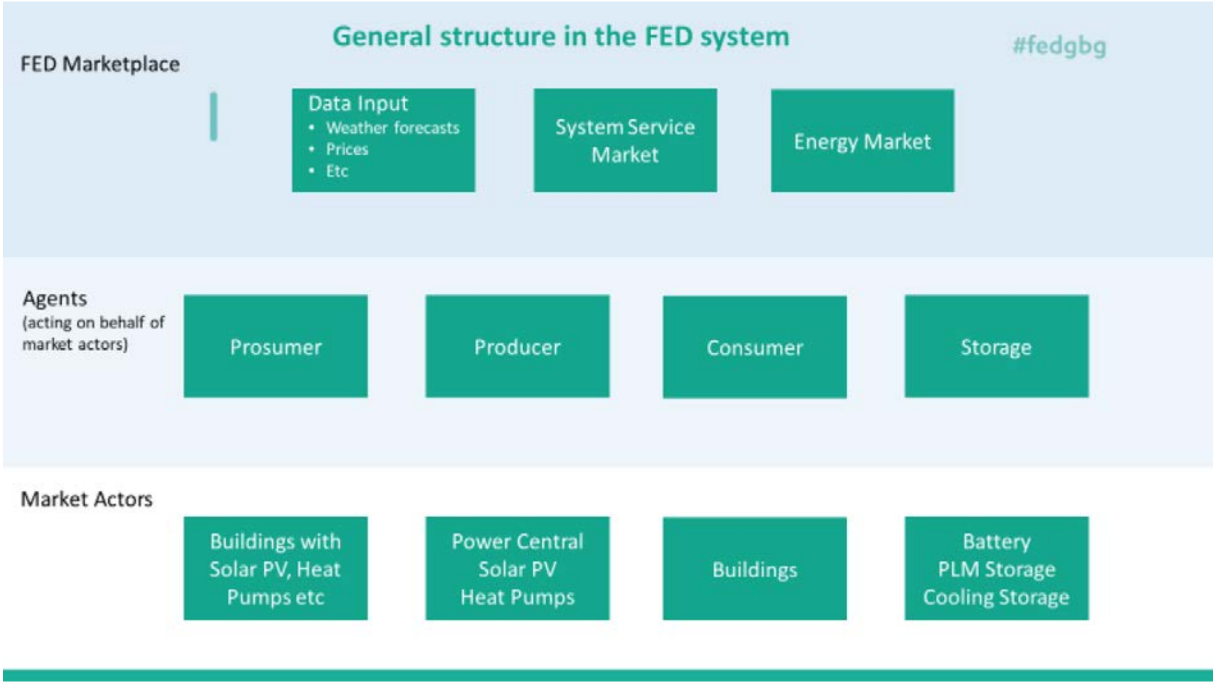

Figure 3: full market design of the FED

It is the third picture, with the nice name figure 4, that is needed to understand the multi commodity system and it shows the market-solving, in the unit named Ericsson IoT Accelerator.

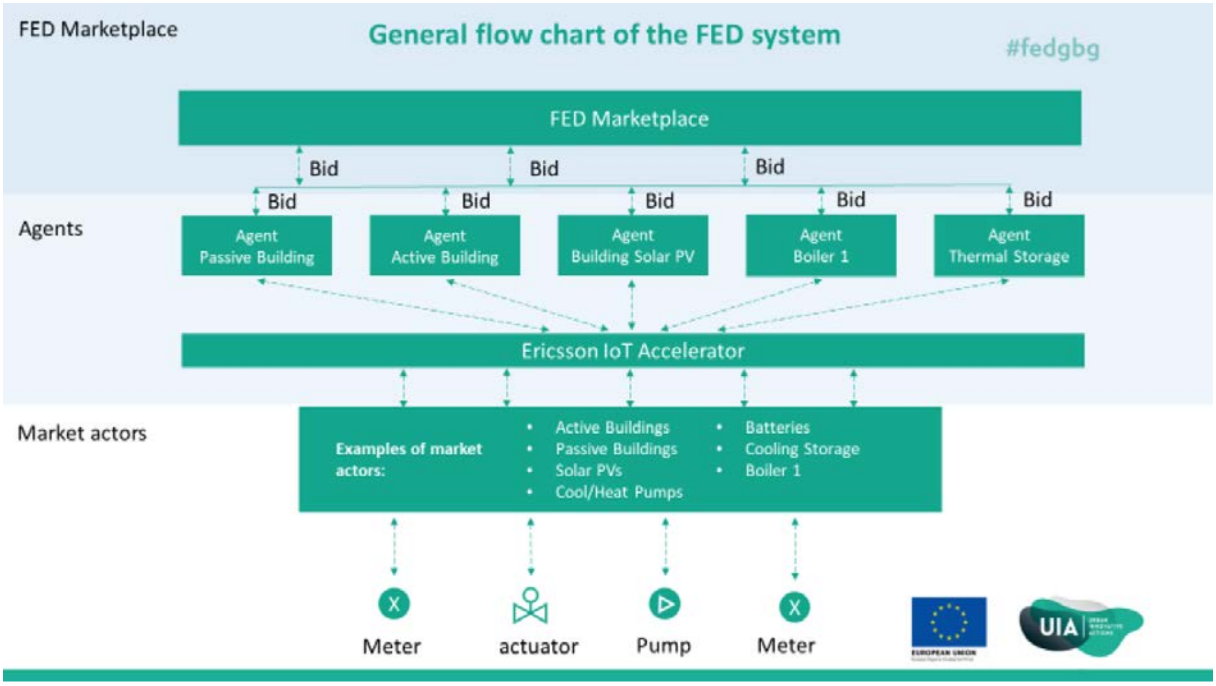

Figure 4: market solving in the FED

3. A view on the functioning FED system

The infrastructure and control required for connecting all facilities included in FED and allowing for local market energy trading are fully operative since January 2019. This consists of the distribution networks for heating, cooling and electric energy that are part of FED and the hardware that are connected to these.

Results as a testbed

The different parts of the FED market affect each other through the total economical optimization, so it is only when all of the agents are in operation that the total effect of the FED-system in reality can be verified. This has not been the case for a full winter yet, which is the reason the monitoring and evaluation will be in Journal 6. It is however already possible to look at some sub-plots:

Electricity

As can be seen in table 1, the imported electricity is reduced for the campus area when considering the FED investments and control system. The main reason for this is due to the increased local production from solar PV plants and the electricity turbine. The use of absorption chillers and heat pumps increased the demand for electricity. The electricity for charging the batteries are higher than what is extracted from the batteries. This is due to the losses in the battery, and is, from a market perspective, compensated for by the variations in electricity price.

Table 1: Electricity in the FED system

Unit	Without FED System (kWh)	With FED System (kWh)	Change
Turbine	-	1 879 203	
PV	90 690	703 585	675,8%
Import	35 543 349	33 315 393	-6,30%
Absorption Chiller and ambient air cooler	-117 270	-87 635	25,3%
Heat pump (VKA1)	-407 104	-518 940	27,5%
Heat pump (VKA4)	-769 053	-435 960	43,3%
New Heat pump	-	-480 668	
Refrigeration machine @ MC2	-	-2 309	
Battery @ AWL charge	-	-16 568	
Battery @ AWL discharge	-	14 953	
Battery @ EV Charge	-	-8 284	
Battery @ EV disharge	-	7 477	
Electricity Demand Buildings	*-34 457 882*	*-34 457 882*	

Heat

For the heat system the exchange with the district heating system increased with the FED system, as can be seen in the heat table. This is probably due to the possibility to sell heating when it is expensive and buy when it is cheap. The usable heat from the boilers are reduced with the FED system and also a larger share of the heat demand is covered by heat pumps, certainly during the heating season. However, as the system is operated today the possible flexibility in how the heat pumps are used is limited since the cooling output from the heat pumps must meet the cooling demand during the winter.

Table 2: Heat in the FED

Unit	Without FED System (kWh)	With FED System (kWh)	Change
Boiler 1	17 874 230	8 324 733	-53,4%
Flue gas condenser	2 614 140	937 931	-64,1%
Heat pump (VKA1)	1 221 312	1 556 819	27,5%
Heat pump (VKA4)	2 307 158	1 307 880	43,3%
New Heat pump	-	1 490 070	-
Export Heat	-2 157 046	-3 344 855	55,1%
Import Heat	2 940 433	5 373 023	82,7%
Heat from Boiler 2	-	49 219	-
Heat from turbine	-	9 174 931	-
Absorption Chiller and ambient air cooler	-5 159 892	-3 855 937	13,4%
Savings from Adv. building control	-	310 873	-
Refrigeration machine @ MC2	-	5 540	-
Adv. building control charge	-	-66 407	-
Adv. building control discharge	-	50 973	-
Building storage charge	-	-46 082	-
Building storage discharge	-	36 045	-
Heating Demand Buildings	-24 800 482	-24 800 482	-
Excessive production	0	360 469	-

Cooling

During the winter period the cooling is provided by the heat pumps while during the summer period the cooling comes from either the heat pumps or the absorption chiller, depending on the price. The reason for the reduced cooling from absorption chiller and ambient air coolers is that the ambient air cooler was not in operation after 2018. During the summer, the utilization of the absorption chiller is slightly higher for the case with FED compared to the case without FED. It should be noted that due to the decision not to use the ambient air coolers after 2018, the cooling produced from ambient air coolers has been treated as cooling from the absorption chillers in the base case. Hence, the cost and emissions in the base case is likely higher than the actual numbers.

Table 3: Cooling in the FED

Unit	Without FED System (kWh)	With FED System (kWh)	Change
Heat pump (VKA1)	*732 787*	934 091	*27,5%*
Heat pump (VKA4)	*1 384 295*	784 728	*-43,3%*
New Heat pump	-	1 052 662	-
Absorption chiller and ambient air cooler	*2 579 946*	*1 927 968*	*-25,3%*
Heat pump MC2	-	*4 387*	-
Water basin charge	-	-66 867	-
Water basin discharge	-	60 058	-
Cooling Demand	*-4 697 874*	*-4 697 874*	-
Excessive production	*0*	*0*	-

Conclusion so far:

Regarding the operation of the different units, it was found that the units are scheduled differently under the FED market compared to the case without the market. One reason for this is due to the added investments but also that the price structure is more dynamic in the FED market. It was found that the usage of heat pump increased under the FED market but also that the import and export of heat increased. The reason for this is due to the more dynamic prices, which are possible under the FED conditions, which creates higher incentives to export when prices are high and to import when prices are low. For the cooling, the absorption chiller is used more during the summer due to the low heat price while the cooling during the winter is provided by heat pumps. In addition, the utilization of energy storages, both in buildings and batteries increased when a CO_2 factor was introduced.

4. Challenges

This particular series of journals on the FED project, of which this is number 5, has always paid attention to the challenges that were met during the implementation of the FED project. This is always very relevant in EU funded projects as solutions to barriers or, more abstract, changing perceptions of barriers may -if well disseminated- find their way in the European landscape and help speed up progress, in this project, in the energy transition.

These challenges were always loosely formulated to see to them fitting all UIA projects and in some journals the operational actuality of implementing the project had little to do with the pre-formulated challenges. An example can be the challenge: 'leadership for implementation', which was not so much of an issue in Gothenburg because most project partners were also the beneficiaries and have an institutionalized cooperation. One of the journals (number 3) focussed on how this became the case and the role of Johanneberg Science Park in that.

If we stay away from what can be considered normal issues in collaborative projects and focus on what was relevant in the FED application we can highlight some issues and then dive deeper into the main issue of the FED, but probably of most innovative projects, which is replication and upscaling.

To consider the challenges at the end of the project is a logical consequence and can perhaps also learn us about the way we saw the energy transition in 2015 when the FED project was proposed, and when the UIA developed it's challenges. Let's list them for the overview.

4.1 Leadership for implementation

There's a lot to say about leadership. In the UIA field, we look at the municipality for leadership. In the FED-project the city used the opportunity to have Johanneberg Science Park, to take the leadership role. This obviously worked for the project, but not every city has a Science park like Johanneberg Science Park.

Since the project is technically over, one can almost conclude there were no leadership problems for implementation although these may exist at the end of the project, when steps could be taken to scale the system. However, at the moment there are still too many uncertainties about the impact to do that.

Furthermore, the legislation does not allow it, so EU and national regulation and taxes have to come in. Legislative challenges are hampering growth of systems like these. Still the new EU legislation on energy communities[3] may provide possibilities to show more leadership in upscaling small energy systems.

It seems Ericsson and Göteborg Energi are not the players that will take the next step with the FED so for something to happen leadership has to stand up to organize something. Vattenfall, EON, and smaller companies are providing this. But the city has the overall responsibility so the problem of legislation and certainty of impact hold them back.

[3] https://www.emissions-euets.com/internal-electricity-market-glossary/2095-energy-community

4.2 Public procurement

Since Akademiska hus and Chalmersfastigheter have their normal procedures, these have been implemented and worked for the procurement. One has to keep in mind though that the whole energy system was mostly there, and the new hardware and software was added in the project. Both battery units were also part of other projects, for financial and academic reasons. The interdependency with other projects adding systems means you cannot fully control the additions from other parties, which let to timing issues.

Most of the hardware was rather standard and the procurement of the innovative part, to be produced by the programmers of Ericsson was done via partnership in the FED project to help develop the unique agents and also use some of their commercial off the shelf solutions to make all the components fit.

So, in the planning of the project it is useful to know which parts make it innovative and which parts are more 'normal' building blocks. The normal blocks do not need extra procurement attention because you have procedures in place. It's the innovation that's hard to procure and in this case has been co-created with Ericsson, in cooperation with the other project partners.

4.3 Integrated cross departmental working

Although originally used for municipal organisations the aligning of interests and priorities of such different companies and employees as energy suppliers, real estate owners and academic researchers has been a constant topic in the past three years. When I visited however, I have always found inspired people that seemed to strengthen each other much more than I expected and had little problems formulating common goals.

And of course, this cooperation was established at the campus area before the application was written and when the possibility came the project was designed. The local partnership and knowledge and long-term connectivity will see to continued cooperation. The players have common goals and are able to recognize these.

One can also focus at a people aspect. Gothenburg is not a big city so the people are connected and are moving around over the leading organsations in the town, almost by default. This creates short lines, there will always be somebody who knows somebody. This is quite relevant when you want things to work and happen at the operational level of implementing a project. Respect is important and builds up in long term relationships.

Finally, I would like to reiterate the conclusion in Journal 3, which looked closer at science parks and concluded:

Recapturing the Gothenburg situation as described, I would argue that the last two points (execute, measure, collaborate & create) and possibly the first (create a unified mission) entail the FED project but that the common goal and motivation are very much the continuous process going on at Johanneberg and personified by Johanneberg Science Park. This conclusion may prove that JSP can be a great, natural choice of project-lead in projects with the same typology, which is also testified by the list of EU-projects they are engaged in.

Of course the main winner here is the municipality, or the public if you want. By making a relative *small investment it the science park it creates consensus over a list of organisations that it would never manage to, if the system would not exist. How else would a housing company come into contact with a project on driver-less vehicles, or how would a car company learn about solar panels on an inhabited Living Lab[4]?*

4.4 Adopting participative approach

This topic is about common ownership of problems, or even better, solutions.

In the beginning WP4 (energy hardware) and WP5 (software agent development) needed to talk and connect to each other. The energy staff needed to be close to the programmers that make the agents, and that happened only later in the project. It took about a year to recognize this. This was a very relevant connection to make because the Ericsson programmers are normally not in contact with the boiler guys. It was concluded that a good contact at a lower level than just the FED steering group in the project was necessary to work together. This is really relevant, time must be allowed for that!

The FED project itself and the institutionalized participation by means of the board of Johanneberg Science Park of almost all partners are -I think- exemplary ways of collaborating.

4.5 Monitoring & evaluation

The time plan of the project was very ambitious. This is very common in EU projects, since all requested elements need to be in a proposal in a very timely manner to get the top-ratings from the evaluators. With monitoring being -by definition- at the end of the timeline, it always suffers from delays and unforeseen things. The caveat is of course that good ambitious innovation projects have unforeseen elements.

The FED system will be in operation longer than foreseen to supply the data over a full winter. The monitoring equipment is working well, and some early overviews of the renewable energy produced are supplied in chapter 2 of this Journal.

Evaluation-wise, there have been constant discussions on elements in the project and their contribution and need from different perspectives, which is for example why the water tank for heat storage was not ordered. These discussions and evaluations with the relevant project partners have resulted in a clear overview and will be presented in the FED final report.

4.6 Financial sustainability

See replication & upscaling

4.7 Communicating with target beneficiaries

The communication with target beneficiaries has mainly been handled by Johanneberg Science Park. They are specialized in business-to-business communication and many of the stakeholders in other science parks follow their communications and transfer these to relevant stakeholders in their ecosystems. Gothenburg Business region is similarly active in Sweden and beyond and

[4] https://hll.livinglab.chalmers.se/

interested parties know how to find both organisations on Twitter, LinkedIn etc.

The FED's final national conference was held in Gothenburg[5] on the last day of October 2019 and there were many businesses that were interested. From the group of real estate and energy companies, in fact all the important players in Sweden took part in the event. The national and local authorities were present and showing a lot of interest. Johanneberg Science Park and the FED project are helping them to build their knowledge. The Swedish energy agency & the Swedish agency for smart grids have also been interested in particular.

It is fair to say that from a marketing perspective, the FED has pinpointed the right individuals, invited them, they responded, and then the processes of sharing knowledge really started. There have also been articles in branch-related business magazines for energy and real estate. And of course students and academia have been involved and learning via the Chalmers connection.

To eventually go to consumer level with a multi-commodity grid that uses flexible pricing, may need larger steps and different strategies but is not impossible at all. Many mobile-phone operators use the same frequencies -infrastructure- and not many clients complain about it, for example. The FED recommends though, to give very careful considerations to social acceptance in its policy recommendations.

4.8 Replication & upscaling

There's a problem with projects that innovate at the systemic level. At a system level, it only makes sense for a building to be used as prosumer if there's infrastructure to sell its production and if there's a buyer. An investor in infrastructure needs to install the right capacity, but also needs to regather investments during the life-span. This may be more unpredictable if the system changes. PV-systems and heat pumps can be more or less profitable and services like energy storage may blossom in a new system. This is all being tested in the FED. That's not the problem.

The problem of the upscaling of an innovative system is that there are many components and although the component owners have been very supportive in the project, the system itself is not their core business and after the project, well, life goes on. Perhaps there can be a specific component push, by an enthusiastic advocate or perhaps even patent-holder (like with linear innovation), but there's no 'natural' carrier of the burden of the responsibility (or budget) of upscaling and replicating a systemic innovation.

With regard to the FED system it has already been concluded that with the setup of the ICT platform and marketplace that has been constructed it has been possible to have a stable operation and add new agents as they are ready to be implemented. The FED-system has shown a strong stability despite these disturbances, which is a major advantage in a real situation where new actors would join in a local market at different stages.

After workshops in Denmark and the Netherlands, the project has proposed a list of 'must-haves' and a list of 'nice to haves' for further upscaling. Ideally all 'must-haves' are covered, in which case the FED system could probably be replicated. In reality though, it is likely that certain elements of the FED are replicated and others not, depending on local variations. The list that the FED produced reads as follows:

[5] https://youtu.be/7N3PdLmE7Yw

Table 4: Must-haves & nice to haves for a FED replication

General location Criteria	
Large enough IES to make the FED system feasible	Must have
Sufficient know-how locally and regionally	Must have
Business model opportunities	Must have
Motivated and engaged actors	Must have
Driver of project (actor)	Must have
Owner of project	Must have
Trust in project owner / driver	Must have
Area with more than one energy carrier	Must have
Financing and capability for increased customer support	Must have
Willing property owners	Must have
Transparency (overcome distrust)	Must Have
Network of actors with long standing relationships	Preferred
Area with one energy supplier for hjeat and electricty (or other energy carrier)	Preferred
Strong community feeling	Preferred
Possibility for community solutions	Preferred
Ability for interconnection with other integrated energy systems (IEA)	Nice to have
Areas / cities / companies present with sustainable profile & ambitions	Nice to have
Urban region	Nice to have
Financially strong municipality	Nice to have
Non-renewable energy production in energy mix	(not) Nice to have

Others need to step up and see how they can earn money with a system like this. At the moment, the incentives are not there so little happens past the realisation of one-off smart grids. The FED, from that viewpoint has been a preparatory work, for other experiments and has possibly laid some foundations to build upon or perhaps use for insights when regulations start changing.

It is expected that Journal number 6 and possibly the Zoom-in, both foreseen in 2020, go deeper into the replication strategy and business model. The reason for not developing a replication strategy now is that the monitoring figures are not ready. It is therefore difficult to see if there are winning or losing technologies in the system, or interdependencies that we cannot foresee now. The reason for that is that the FED-system that is operating since January 2019 is not a constant entity since new agents have been added to the system as they have been ready and tested. One can therefore only monitor actions and analyse outcomes that have taken place during this intermediary time when the FED-system is operating but not in its final state. Because of that, it is not possible to see which parts of the FED contain the largest potential at the end of 2020. In sales terms, the ‘compelling points’ are not measured yet.

Policy recommendations

In the end of the project, the FED has published the following policy recommendations[6]. They are:

1. Strive for social acceptance
2. Direct investments and incentives
3. Define the role of the municipality
4. Enable trading with flexibility
5. Enable testing, demos and proof of concepts

A summary per topic reads like this:

1. Strive for social acceptance

This topic addresses that local energy markets can contribute to more effective use of energy but that there are no regulations for them in place.

At the moment there are as such very limited possibilities to trade between multiple energy carriers and that incentives to implement an energy society are lacking. One of the issues is that for home-owners, or building owners there's no incentive to look any further than their current business. They don't see their homes or buildings as a battery, or perhaps even as a production unit, like in the prosumer situation.

Social acceptance is necessary for successful implementation of new technical solutions and the achievement of changed behaviours.

The policy recommendations in this area address the top EU-level where regulations are set, the national follow up of Article 16 in the Clean Energy proposal and the local efforts needed to inform and support creation of local energy communities.

2. Direct investments and incentives

There is a very large gap between the larger systems in cities and the individual heating demands per building. This topic addresses financial instruments, and in particular looks at the fact that buildings play no role in the system trading the CO_2 rights.

The policy recommendations aim at the European Investment Bank (IEB) to make solutions like the FED system possible and advocate to design incentives to cities which are obtained when CO_2 emissions are decreased.

3. Define the role of the municipality

The built-in conflict between the goal of creating solutions on the whole, say societal level, to local optimization is being addressed here. Municipalities in particular lack the tools to ensure that local energy communities contribute to a robust energy system.

The policy recommendations are to hand municipalities possibilities to influence and design local energy communities and to facilitate collaboration between the different stakeholders in the city.

4. Enable trading with flexibility

This broad topic focusses the lack of flexibility in the current energy markets and lack of regulations to create them. It demands role-clarification and incentives to use the market to push for energy efficiency.

The recommendations do not push for a different market in total but focus on a couple of improvements:

- Design of regulations for flexibility of the heating market
- Allow tariffs and pricing models to enable flexibility services

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6 https://www.johannebergsciencepark.com/sites/default/files/FED-policy-folder.pdf

- Allow conditions that can capture energy societies
- Change Swedish Electricity Act to allow local systems
- Implement more exemptions from national legislation

5. Enable testing, demos and proof of concepts

Complex system solutions do need to be tested and are often invisible to important stakeholders, as the addressed problems are not identified by all.

Recommended solutions are to create conditions for new business models for flexibility services with multiple energy carriers by allowing exemptions from current regulations in selected demo projects on district or city level. Furthermore, the FED team advises to enable more demos via financing from national and international programmes.

5. Learning points and next steps

Gunilla Åkerström from the city of Gothenburg puts it eloquently when she states:

'We know that the societal challenges ahead are not something that individual actors will manage by themselves. That's why it is important for us as a city, and the development of our core services, that we become a good player in various forms of collaborations with industry and academia'.

She addresses a collaboration issue that is needed in every large city in Europe and at the same time, she is speaking precisely about the FED project in which different actors produce, trade and consume in a new manner. Never before were heating, cooling and electricity traded in one system like the FED.

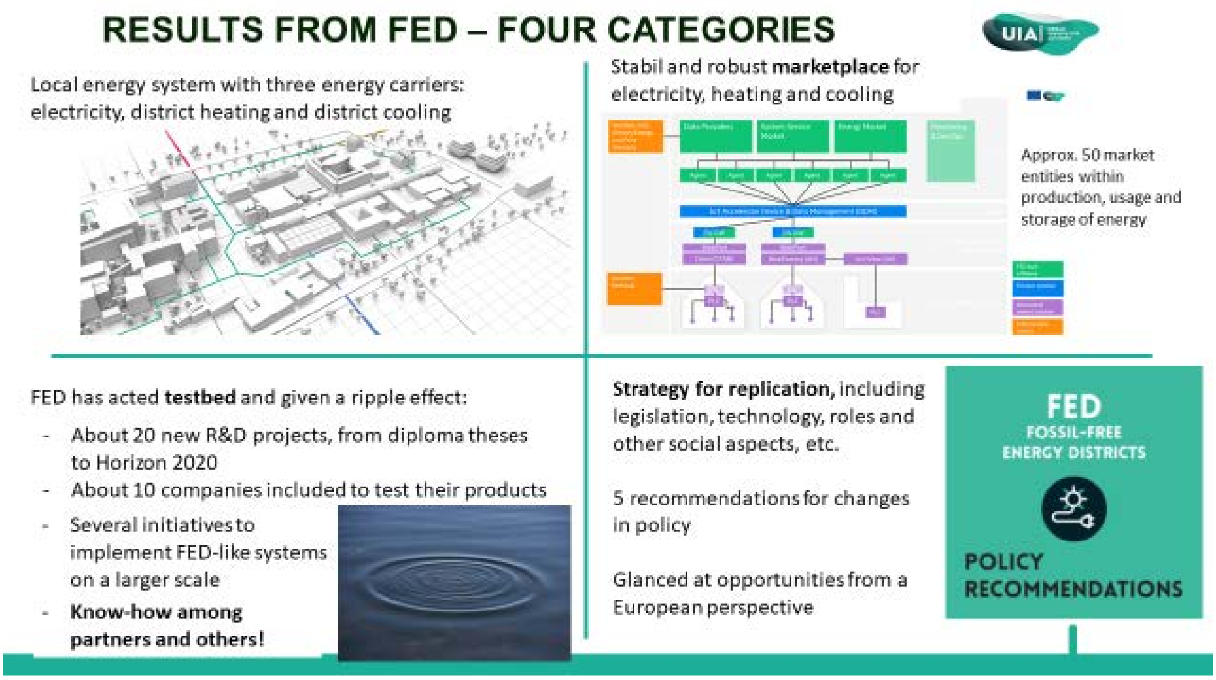

Figure 5: Four result categories from the FED project

One important learning point is that it is possible to trade electricity, heat and cooling in one system. The drivers for innovations like the FED are the growth of distributed and renewable electricity generation, which demand for coordination between the large/small scale and the distributed/centralised production under the condition of grid stability. Against a background of digitalization, urbanization and electrification, FED has made a bold demonstration how to add flexibility in the existing situation at Johanneberg.

The demonstration also made clear that the cost of the market solver are not too high. At the same time the project learned that it is not so evident who has the natural role to be the market operator. These learnings are very much in the experimental field because they basically take place outside the law, in the law exempt situation at the Campus.

Another learning point is that capacity building (education) is very important. The understanding that buildings with advanced building control systems can become prosumers -or batteries- in an advanced energy system is not one you would call common knowledge!

Of course, it became clear that updated building control systems are needed for advanced systems and if you want to replicate FED solutions. The FED Project also reported that social acceptance and legislation need careful consideration and will need to change for the FED to become large scale. Directions for next steps were already chosen with visits to Denmark & the Netherlands and inclusion of the FED in for example the Celsius[7] and Access[8] projects. They will be further detailed in the coming months.

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7 https://celsiuscity.eu/

8 https://northsearegion.eu/access/news/local-energy-systems-a-piece-of-the-new-energy-puzzle/

Urban Innovative Actions (UIA) is an Initiative of the European Union that provides urban areas throughout Europe with resources to test new and unproven solutions to address urban challenges. Based on article 8 of ERDF, the Initiative has a total ERDF budget of EUR 372 million for 2014-2020.
UIA projects will produce a wealth of knowledge stemming from the implementation of the innovative solutions for sustainable urban development that are of interest for city practitioners and stakeholders across the EU. This journal is a paper written by a UIA Expert that captures and disseminates the lessons learnt from the project implementation and the good practices identified. The journals will be structured around the main challenges of implementation identified and faced at local level by UIA projects. They will be published on a regular basis on the UIA website.

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