



INERGIO

“It’s all about clean, light and efficient power”

Luc Conti, CTO

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25.11.2021

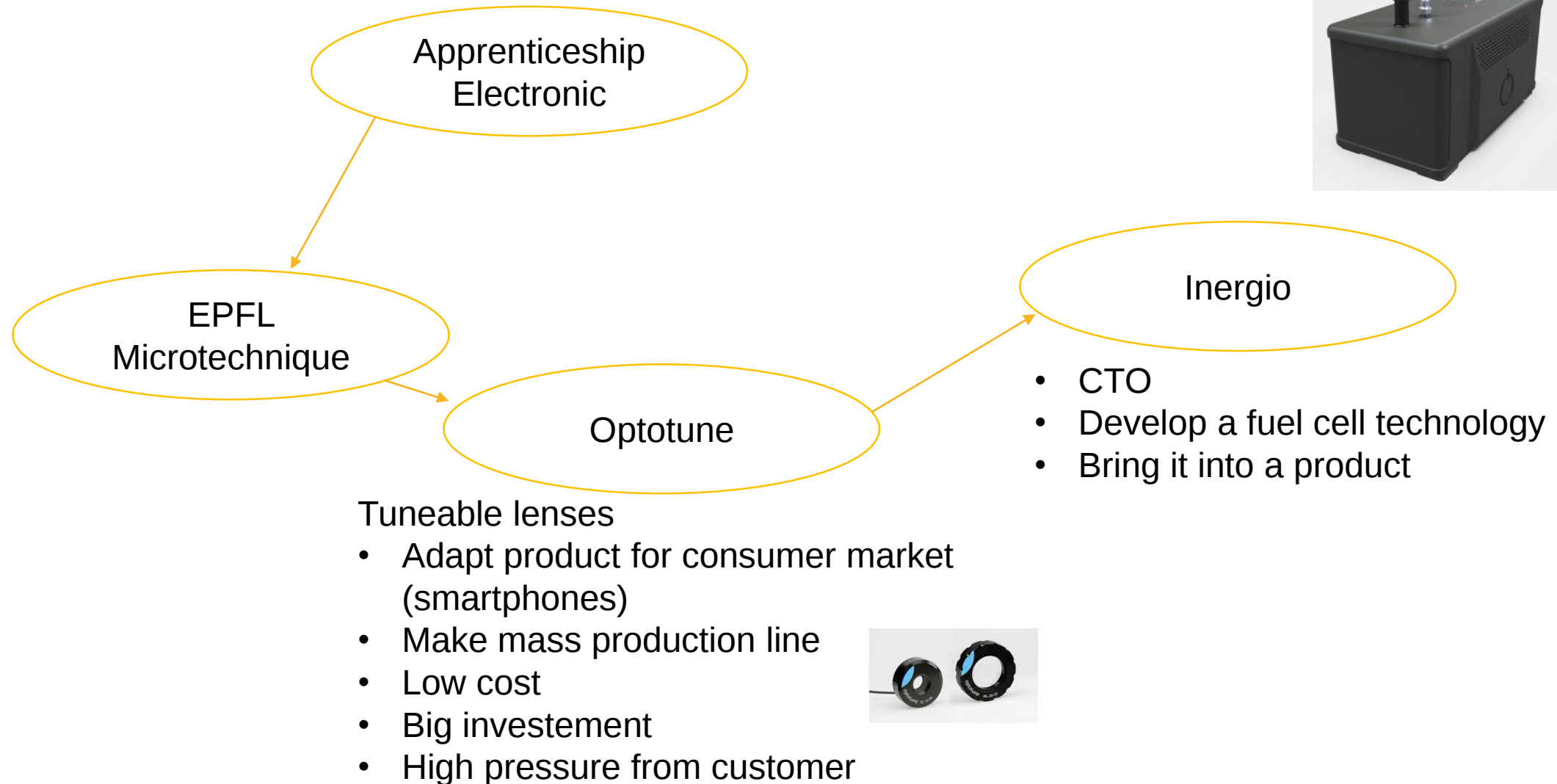


Intro

1. Intro Luc and Inergio
2. Technology explanation
3. Market study
 1. Focus on off-grid mid power
 2. Comparison with actual solutions
 3. Off-grid market sizes analysis
 4. Off-grid market structures

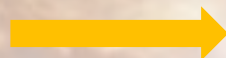


Intro -Luc





Global carbon
emission to ZERO



2050



Climate change is
turned to a true reality

Profound change of
energy systems

Hydrogen and Fuel Cell
are part of the solution

Nations and Corporations have invested

SUSTAINABLE ENERGY

**EU wants to spend \$1 trillion to help
make it climate neutral by 2050**

PUBLISHED WED, JAN 15 2020-8:05 AM EST | UPDATED WED, JAN 15 2020-8:05 AM EST

NREL To Lead New Lab Consortium To Enable Low-Cost Electrolyzers for Hydrogen Production

Oct. 8, 2020

Today, on National Hydrogen and Fuel Cell Day, the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) announced up to **\$100 million**, subject to appropriations, for two new national laboratory consortia to **advance hydrogen production and fuel cell technologies research and development (R&D)** in support of EERE's H2@Scale vision.

POWER

**Fuel cell technology key to
South Korea's energy future**

By Darrell Proctor
February 1, 2019

CNBC

**How Toyota is helping Japan with
its multibillion-dollar push to create
a hydrogen-fueled society**

By Tim Hornyak
February 26, 2019

\$2.5 trillion 2050

HYDROGEN

Source: BofA Securities

Yet, there are several challenges to be solved...

Hydrogen

Storage

Hydrogen

**accessibility and
transportation**

Fuel Cells

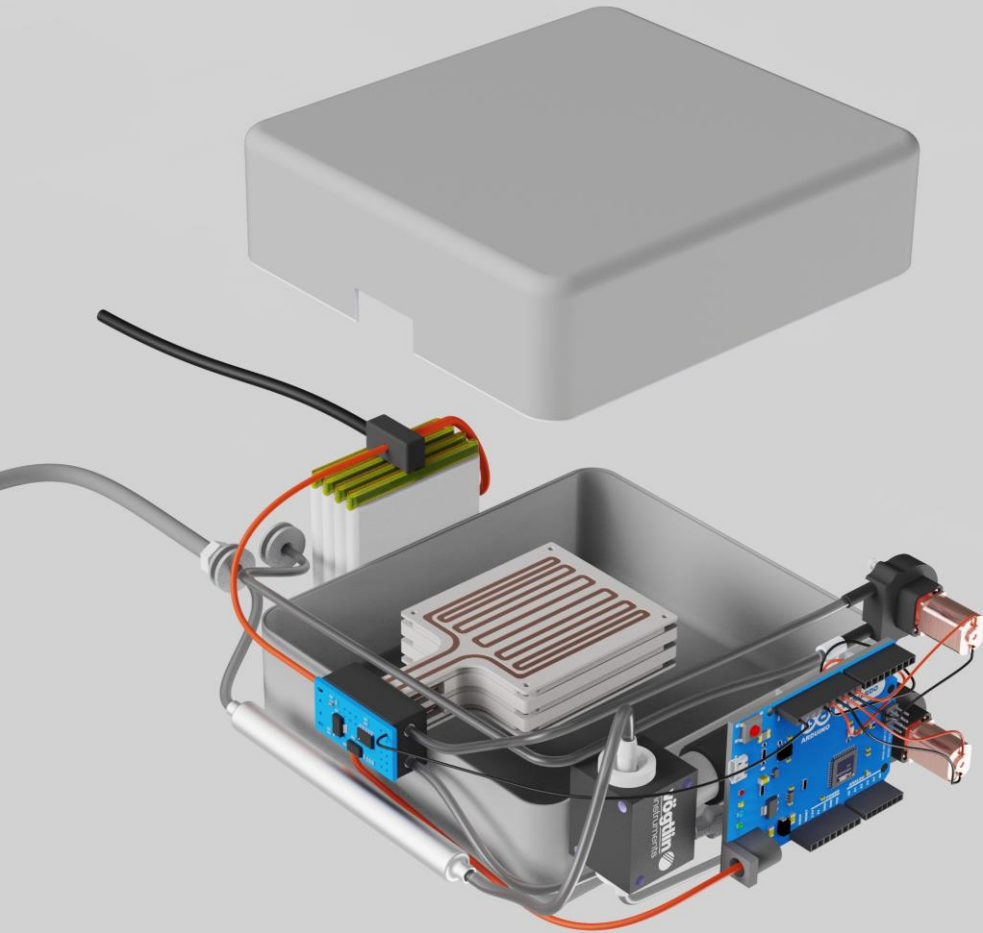
**Limited applications
to stationary and
High Power systems**



INERGIO



INERGIO Innovative fuel cell technology



Compact and light

250 W/kg

3.6 kWh/kg



Fuel Flexible

Today

2030



LPG

60%

100%

Lower CO₂ emission

H₂



Modular and Scalable

From 20 to +1000 W



From Remote applications to UAVs to Backup systems

Off-grid



SAM

1.7Bn
CHF

Now

5-8% CAGR

10 LoI/PoC

UAVs/Robotics



SAM

0.7Bn
CHF

2023-2024

15-30% CAGR

2 LoI

Auxiliary/ Backup



SAM

1.8Bn
CHF

2025-2026

8-15% CAGR

Team



Dr. Mahmoud Hadad
CEO & founder

- ✓ PhD EPFL in Material science and engineering
- ✓ 6 years of experience in microengineering
- ✓ 3 years of business development



Luc Conti
CTO & co-founder

- ✓ Msc. EPFL microengineering
- ✓ 4 Years experience in scale-up startup
- ✓ Strong experience in product industrialization

INERGIO team



Dr. Inès Richard
R&D team



Payam Vahdati
R&D team



Eric Romersa
Business dev team



Nicolas Rospars
R&D team - Intern



Gaëlle Wavre
R&D team- Intern

Advisors

Technical



Prof. Juergen Brugger
EPFL Full Professor (LMIS1)



Prof. Paul Muralt
EPFL Full Professor



Dr. Sebastian Reuber
Founder of Eneramics (fuel cell Co.)
+10 years of experience in Fuel cell sys

Business

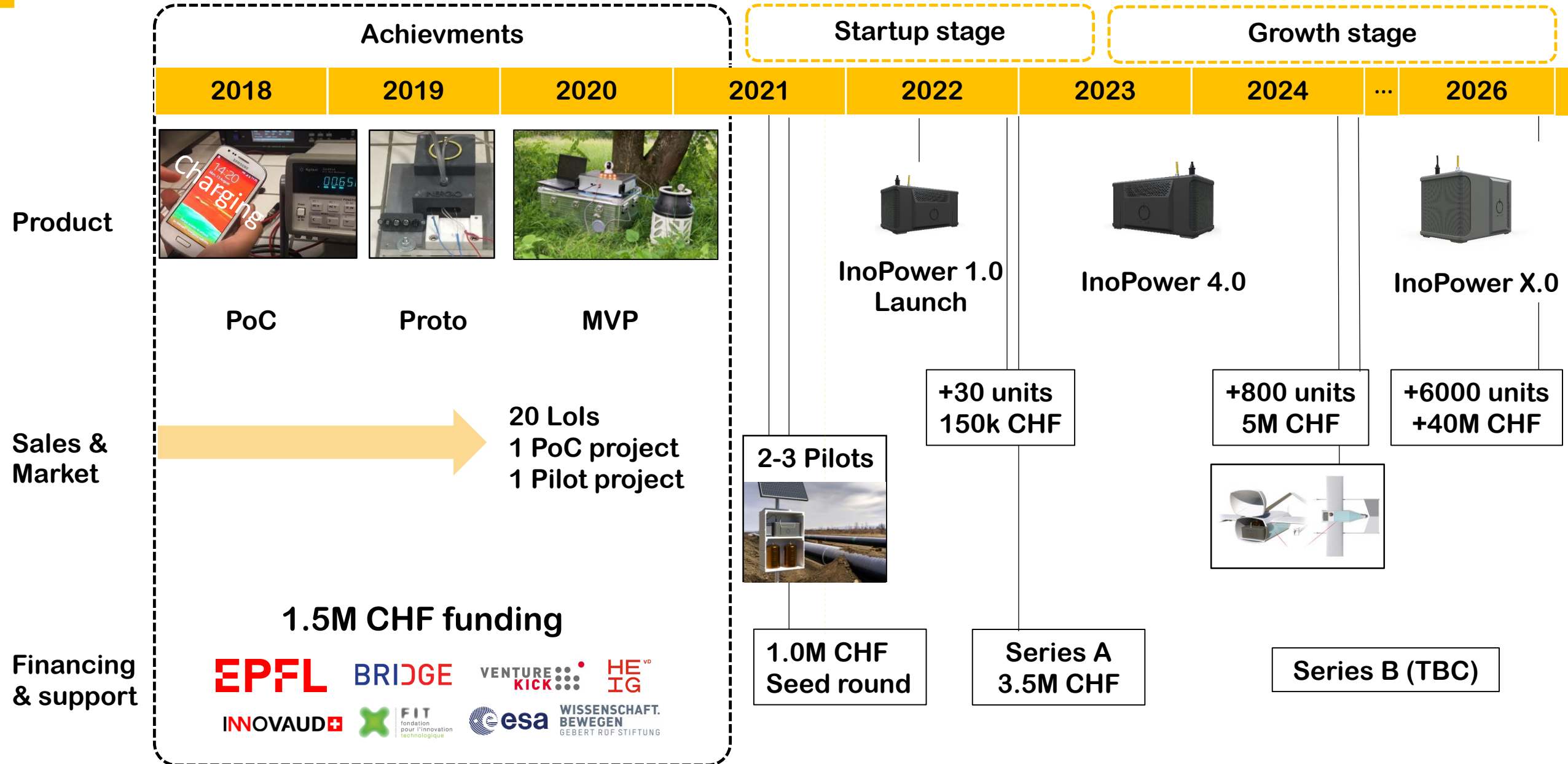


Mr. Pascal Dutheil
✓ Veteran Innosuisse coach



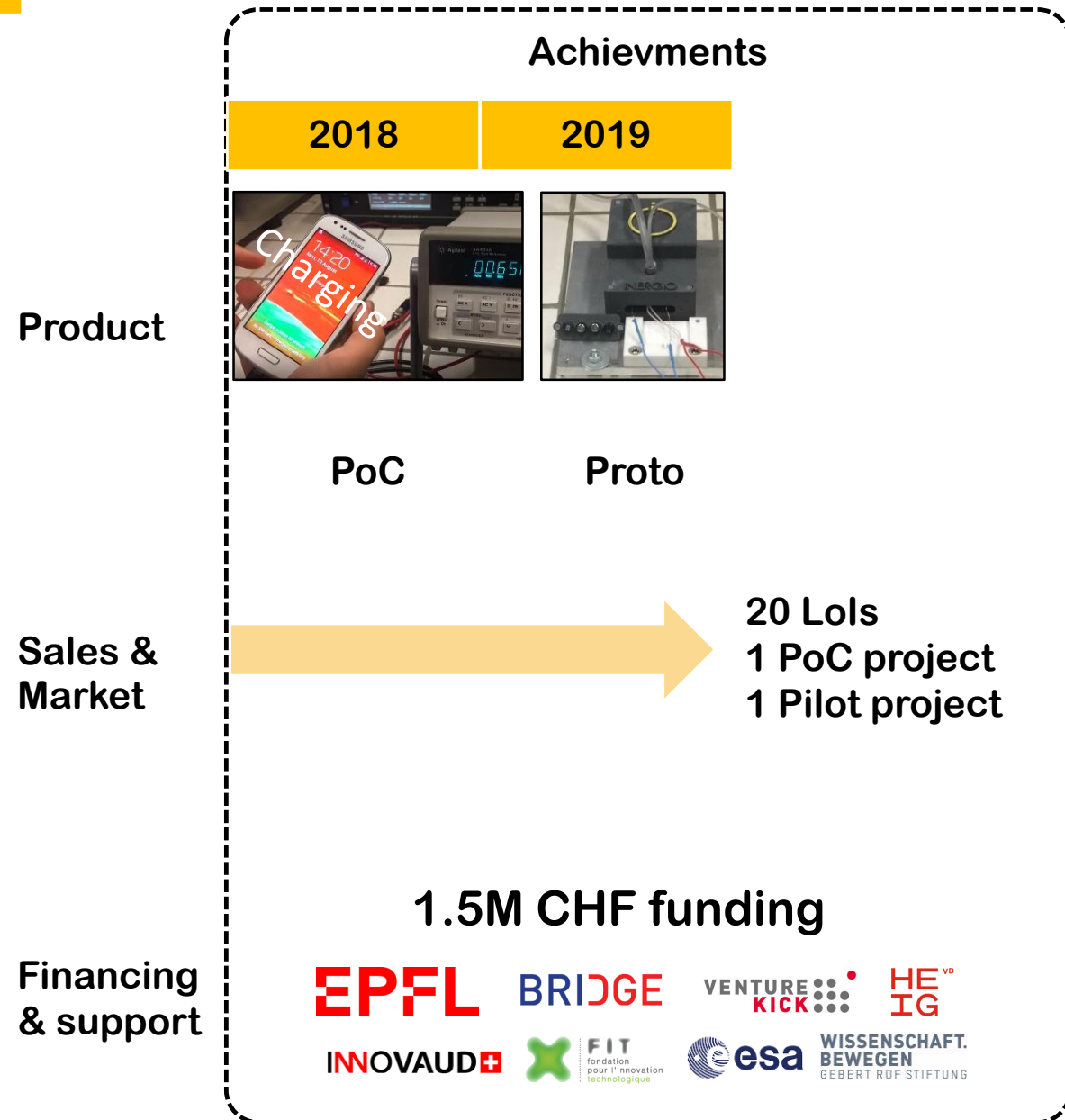
Mr. Jim Lewis - Former CEO
✓ Former **CEO of 4 deep tech** start-up firms in **CH and USA**, include 2 exits





RoadMap

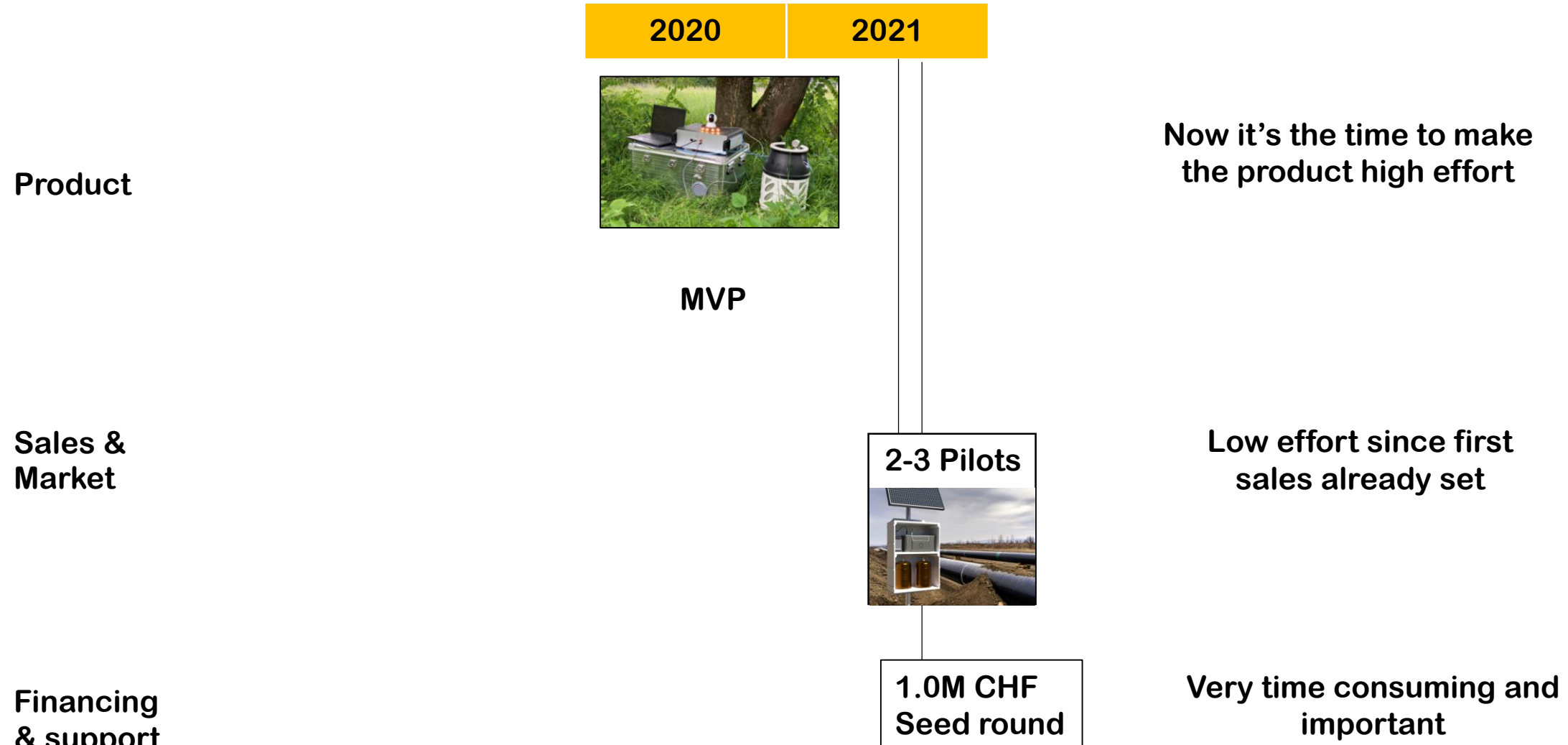
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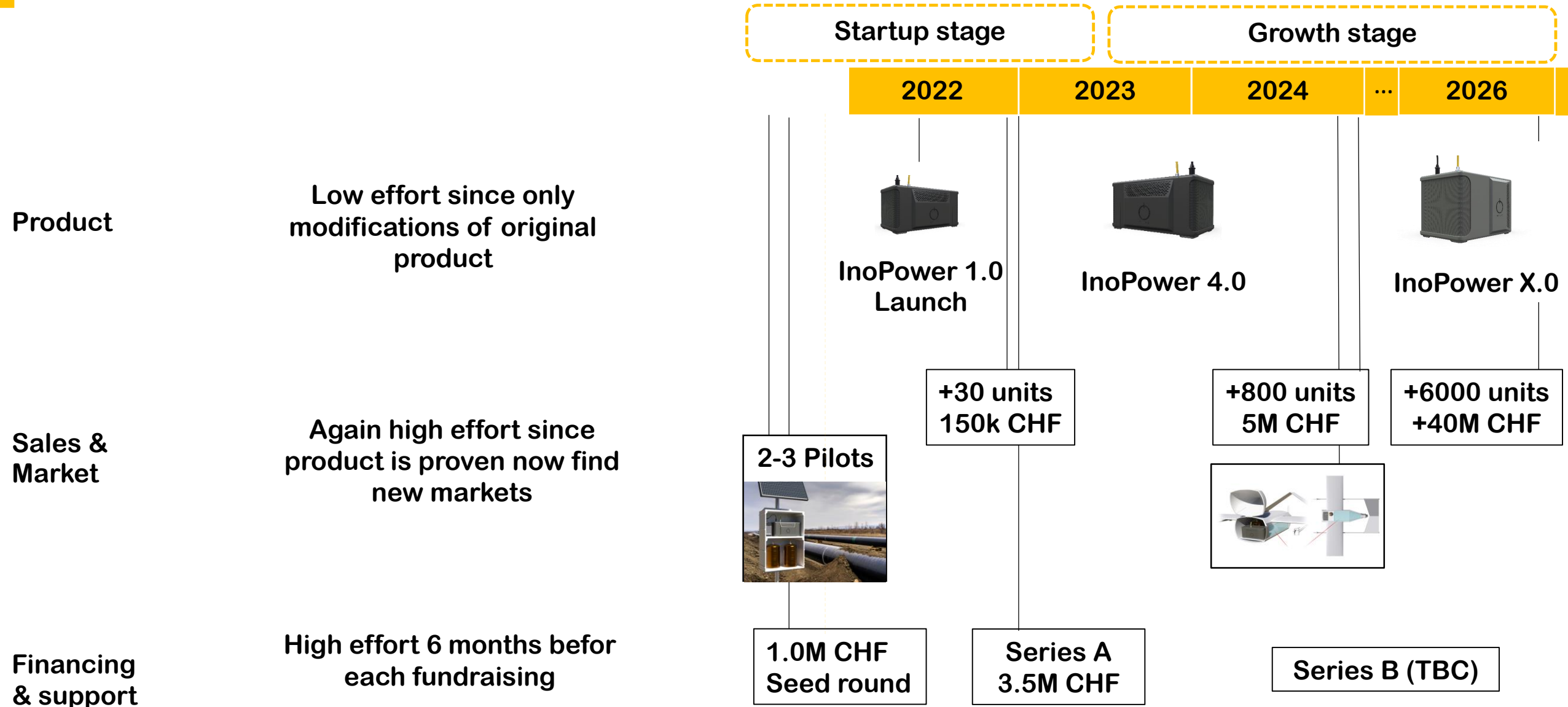


Just to proof the concept but do not make a product. Low effort

Very important since it define the product specs

Very time consuming and important



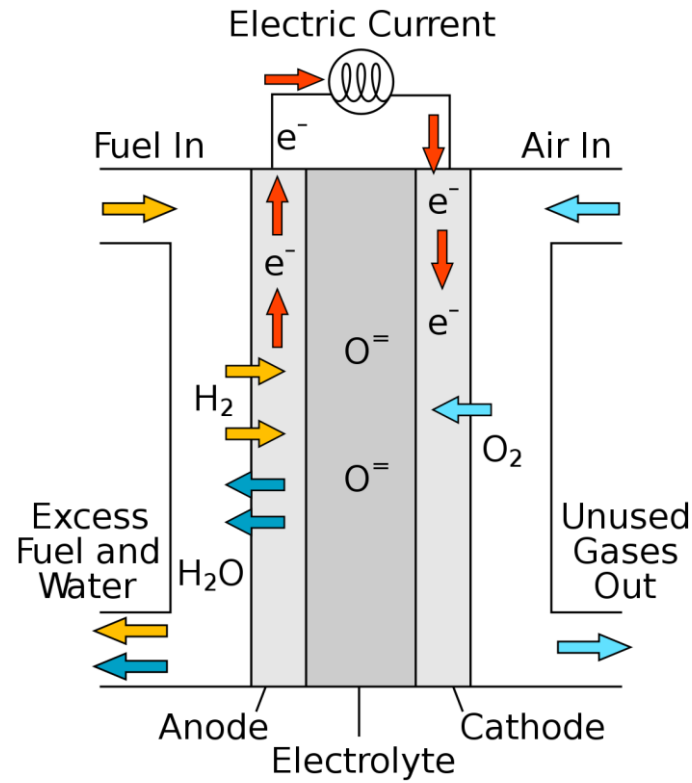




Before market study,
a bit of technology explanation



Intro –Technology SOFC



The fuel (hydrogen gas) is continuously fed to the anode side and the oxidant (oxygen from the air) is supplied to the cathode side.

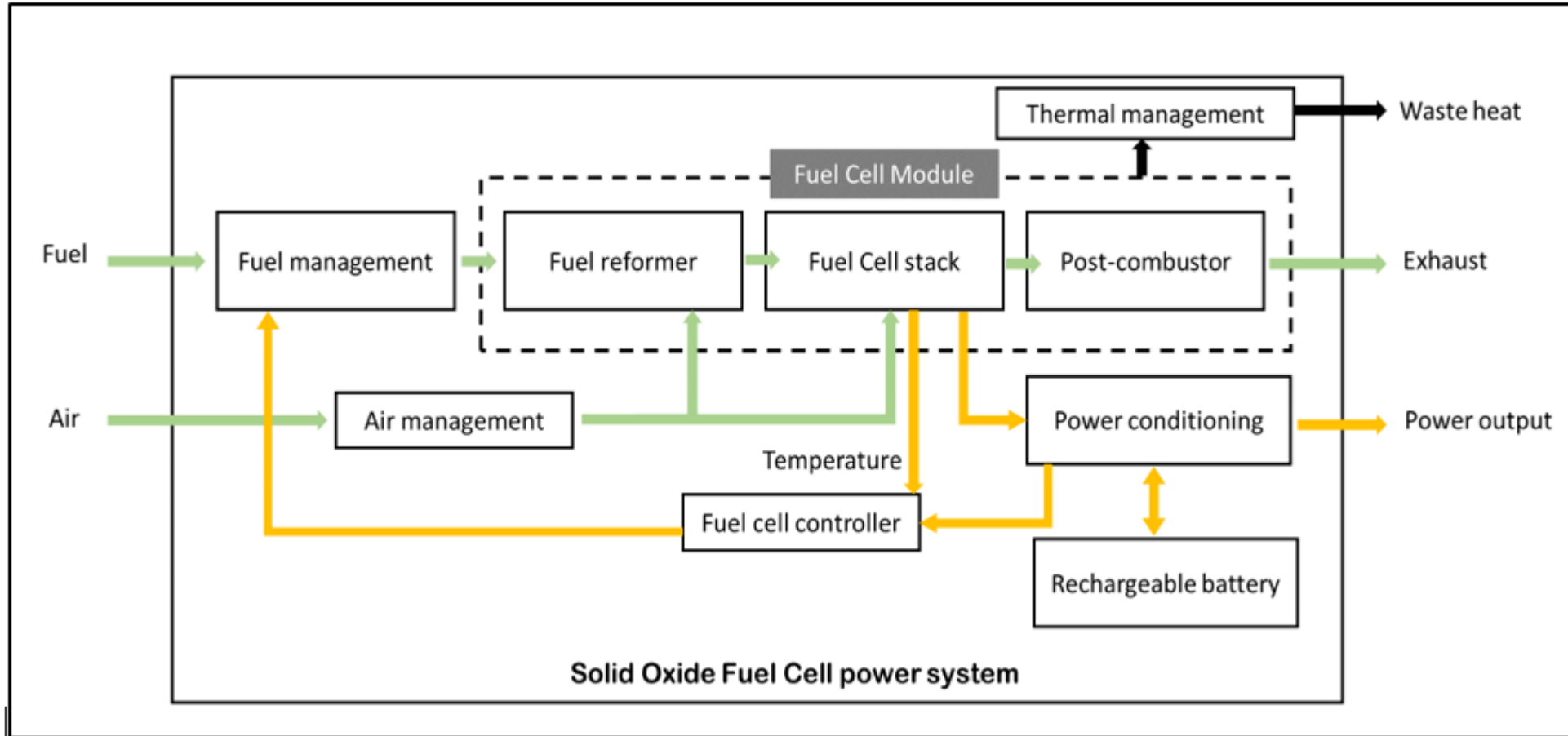
the electrons dissociate and reduce absorbed oxygen and consequently forms oxygen ions ($O_2 + 4e^- \longleftrightarrow 2 O^{2-}$).

The ions diffuse through the electrolyte and oxidize the fuel at the anode side, where the oxygen vacancies are formed in consequence

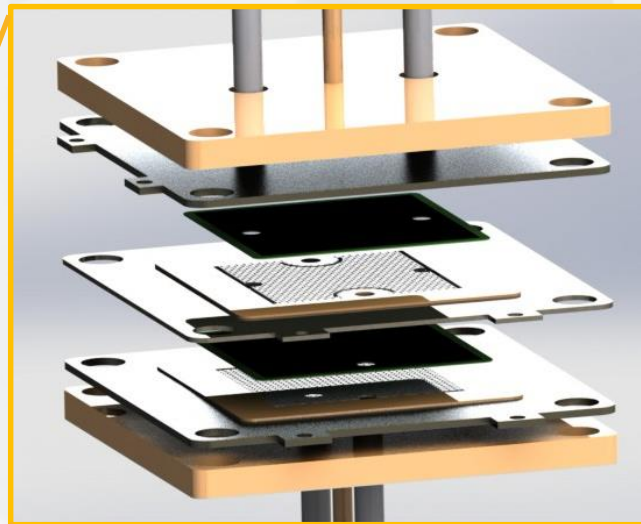
The product of there action is thus electrons plus water steam ($H_2 + O^{2-} \longleftrightarrow H_2O + 2e^-$).



Technology to system



Solid Oxide Fuel Cells



Efficient and Reliable

- ✓ $<0.3\%$ performance loss per 1000h
- ✓ More than 50'000h operation



Fuel flexible

- ✓ Using inexpensive commercial fuel
- ✓ 60x more energy density than Li-Battery
- ✓ Easy adoption to hydrogen

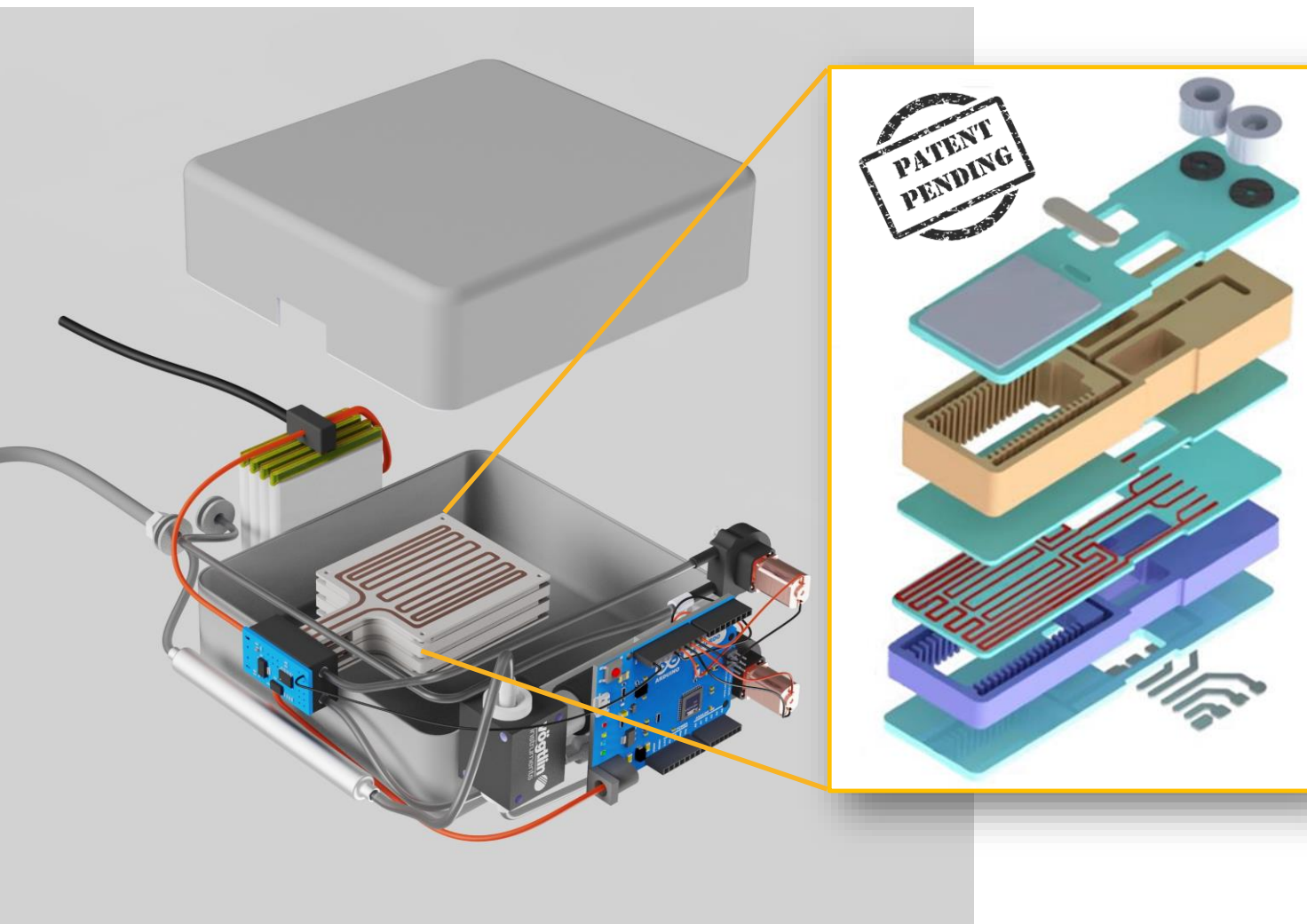
High Operating Temperature



System Miniaturization?!

- Extremely costly
- Not scalable
- Unreliable

18 Secret sauce



+10 years of research

- ✓ Patent pending design
- ✓ Innovative use of composite material
- ✓ Extended thermomechanical stability



80% Lighter

than most comparable fuel cells

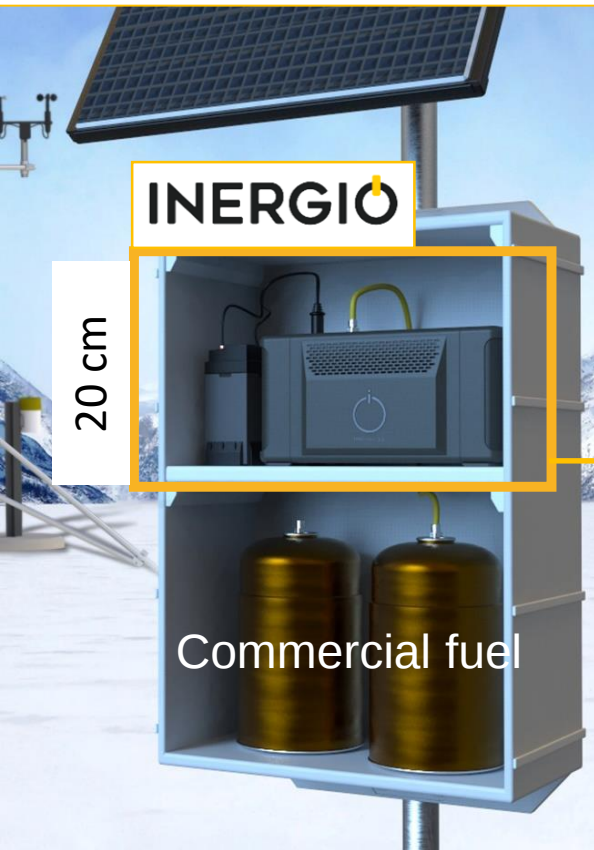


Low CAPEX

No need of cleanroom or complex machinery

Customer offering

19




InoPower 1.0


InoPower 4.0

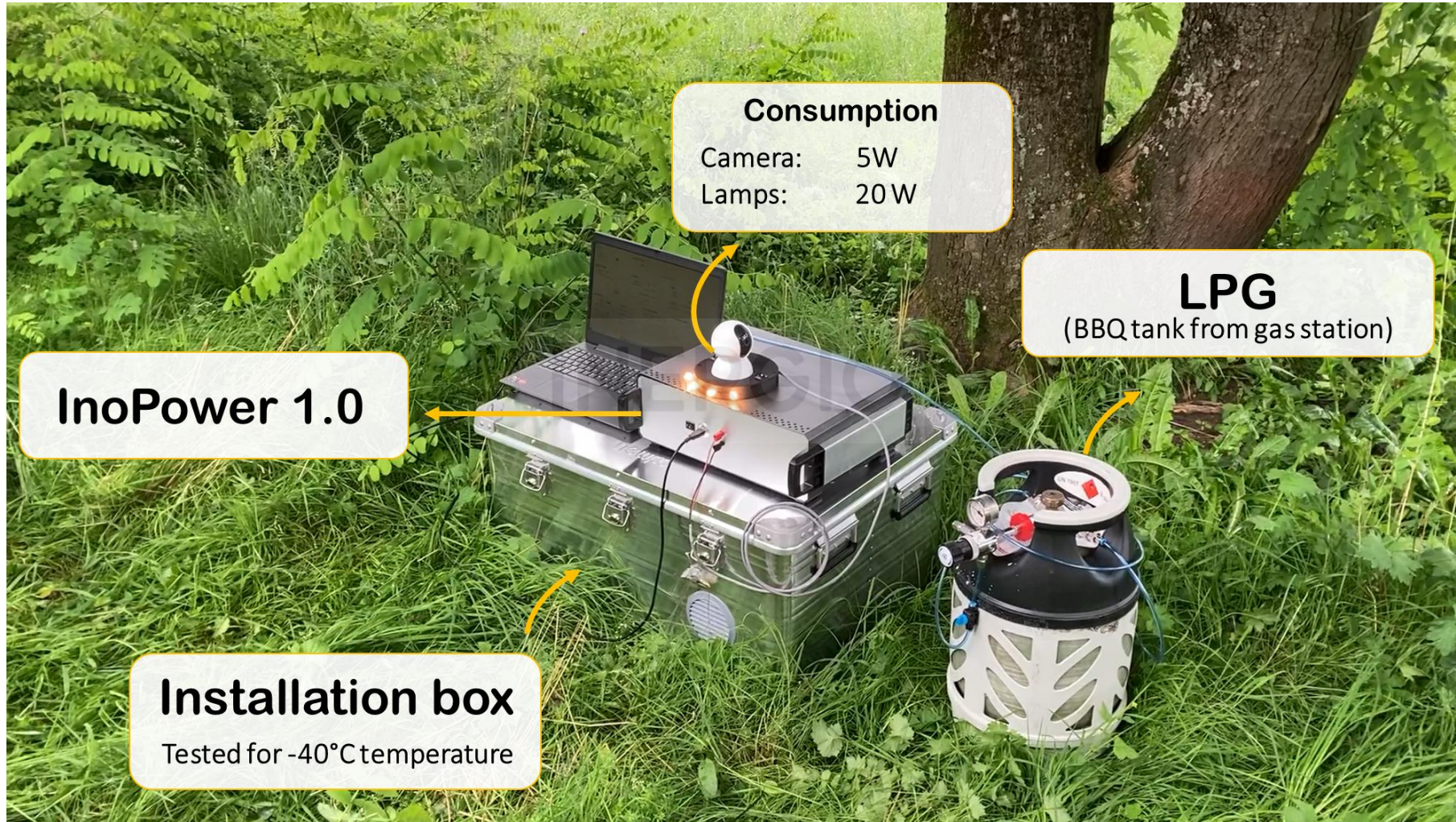

InoPower X.0



Consumable cartridge
(Sulfur removal - Replaced every 1-2 yrs)

Power (W)	Average Selling Price (kCHF)	Target Weight (kg)	Consumable price (kCHF)	Margin
50 → 150	5.5	2.5 → 3.0	0.2	70%
200 → 600	9.6	2.5 → 4.0	0.5	
+1000	12	6.0	1.0	

ANNEX-Video MVP



[Watch the video here](#)



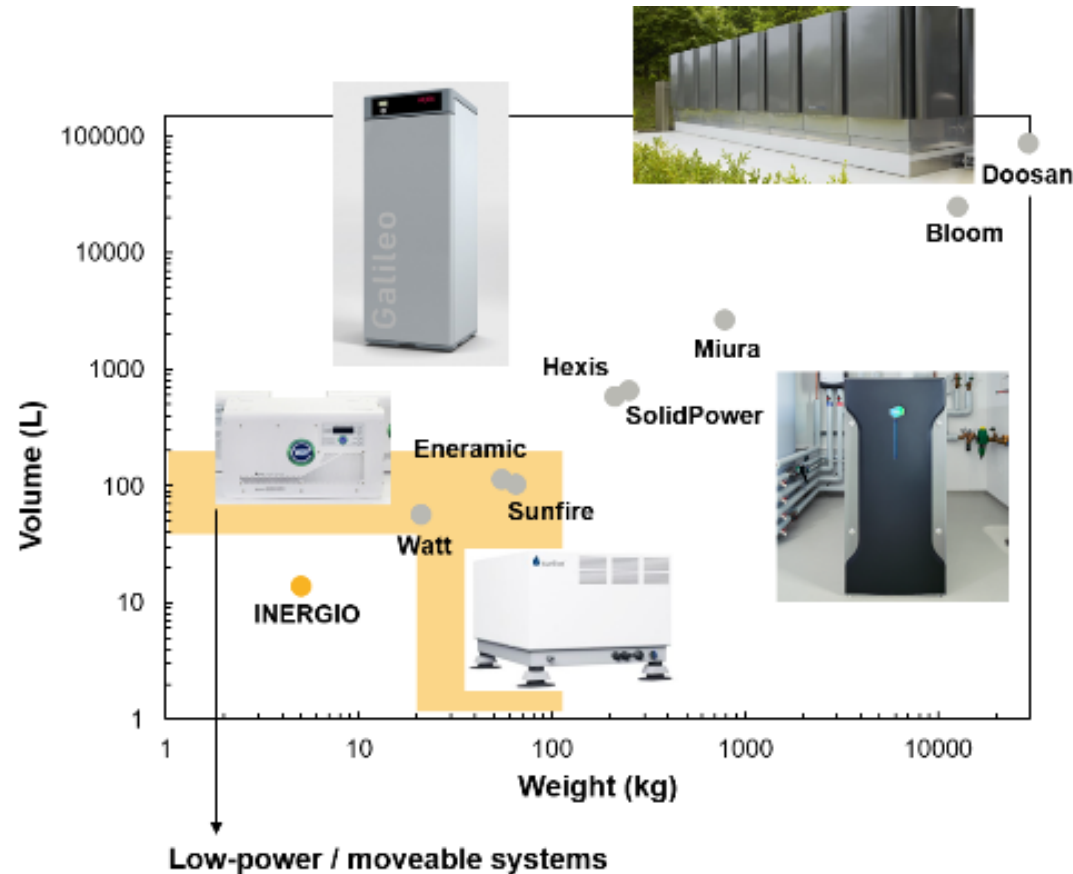
SOFC vs other fuel cells

Table 1 Comparative analysis of different fuel cell technologies

Type of Fuel cells	Conversion efficiency (%)	Operating temperature	System cycling	Fuel	Fuel energy density (kWh/kg)	Fuel Cost (\$/kWh)	Degradation rate	Type of electrolyte	Waste heat management	BoP complexity
SOFC	65	+650°C	Limited	Flexible	13.7	1-2	<1%/kh	Solid	No	Moderate
PEMFC	45	5-35°C	Yes	Sensitive to <5ppm impurity	0.5	8	<1%/kh	Hydrated polymer	Yes	High
DMFC	30	5-35°C	Yes	Sensitive to <5ppm impurity	5.5	9	>10%/kh	Wet polymer	Yes	Very high
AFC	50	<100°C	Yes	Sensitive to CO ₂ in air and fuel	0.5 + pure O ₂	8	3-5%/kh	Water based hydroxide	Yes	High
MCFC	50	+750°C	Limited	Flexible	13.7	1-2	<1%/kh	Corrosive liquid	No	Moderate



Inergio vs. other SOFC



SOFC	Weight (kg)	Volume (L)	Power density (W/kg)
Doosan	29000	88000	15.2
Bloom energy	12600	25000	15.9
Miura / Ceres	780	2700	5.4
SolidPower	250	670	4
Hexis	210	590	4.7
Sunfire	65	105	5.4
Watt	21	58	23.8
Eneramic	55	115	1.8
INERGIO	8	15	>100



Why making a smaller system?



Market study and selection

Look for competitors



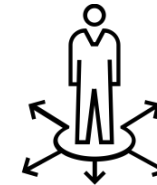
Cost to step in



Success company



opportunities



Failed company



Risks



Free or crowded market





Market study and selection

Overall fuel cell potential market sorted according to power needed

Ultra portable systems In the pocket (<2W)	Portable systems Bag pack (10-500W)	Static high power (1-5kW)	Very high power (10-200kW)
Power bank smartphone	Weather stations	Electricity for home	Backup for servers
Monitoring systems	Security systems	Backup power	Electricity for neighborhood
	Monitoring systems		cars
	communications		
	Drones (delivery)		
	Backup power		



More detailed because our target. -> spent more time on it



Ultra portable (power bank)



- Lilliputian system tried to develop a mini power bank
- Founded in 2002 at MIT
- Raise total of 150M\$
- Bankrupt in 2014
- Never sold a product



Lilliputian systems – consumer market



	Liliputian	Power bank
price	300\$	40\$
Price refill	10\$	~0\$
autonomy	15	5

- Consumer market
 - Low cost
 - High quantities
 - Resistant to any missuses
 - Competitor comes and copy fast

-> consumer market is not good



Lilliputian systems – other market?

- Low power sensors (<2W) are everywhere (road monitoring, weather, air quality, security, defense..)
- With bigger cartridge (20x) possible to get years of autonomy
- <1000CHF, industries can afford it

Why it didn't work?





Lilliputian systems – other market?

Technology limitations with scaling

Low power means:

- low consumption of BOP (balance of plant)
- low heat generated -> demand extremely good insulations (vacuum with reflective walls)
- Extremely low flow of fuel -> expensive sensors and controllers

-> very complex, costly and not reliable system

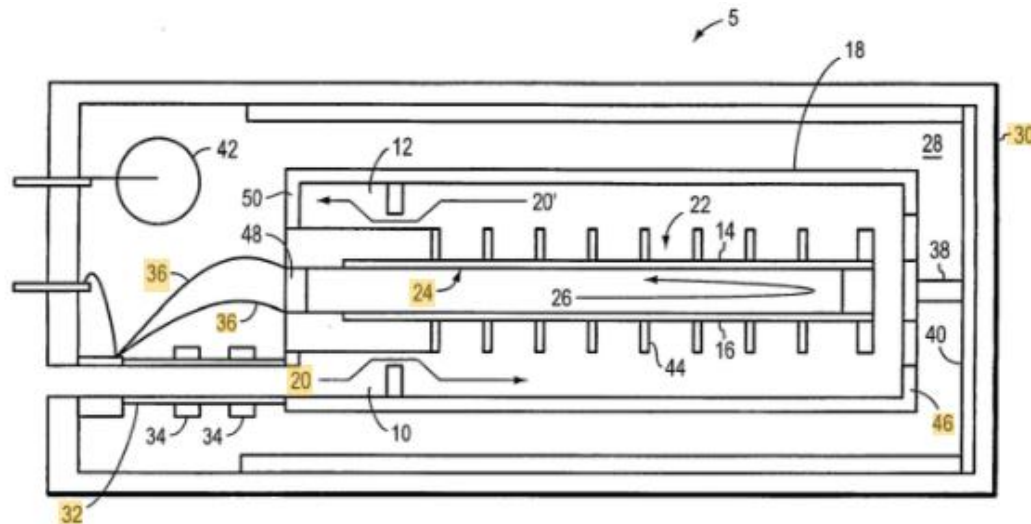


FIG. 1

Patent of fuel cell only



Ultra portable - conclusion

Consumer market too challenging

Too challenging for the technology, very risky



Market study and selection

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↑
More detailed because our target. -> spent more time on it

○ High power – household



Several companies are already selling SOFC to produce electricity and hot water for houses

- Competitors already here (do we have anything better?)
- Our technology (lightweight) doesn't bring an advantage
- Must guaranty 10 years operations
- ~30kCHF per systems -> require huge amount of money to develop the system only for material and trials.



○ Very High power

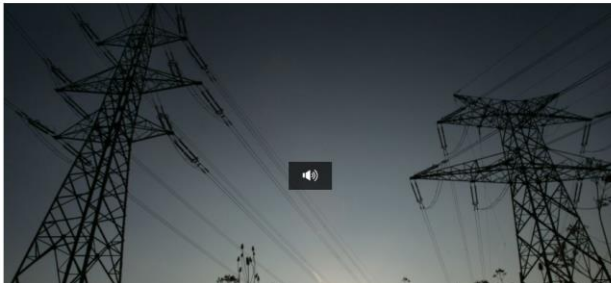
Several companies are already implented

- Systems costs several millions \$
- Who would trust a startup for these kind of installations
- Need a to approach cities -> slow
- In Europe installation that works with gas are not very popular



Suisse Modifié le 17 octobre 2021 à 16:42

**Des centrales à gaz pour pallier le
risque d'une pénurie d'électricité?
L'idée séduit**



However, interesting market for future



Market study and selection

Overall fuel cell potential market sorted according to power needed

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More detailed because our target. -> spent more time on it

Portable mid power



Weather stations



Oil and gas monitoring



Surveillance



Telecoms



Leisure and entertainment



Drone

○ Portable mid power



Weather stations



Oil and gas monitoring



Surveillance



Telecoms

Requirements

- Small & lightweight system
- Easy to install
- Long autonomy
- No Maintenance
- High reliability
- Weather independent
- Easy to refill

○ Portable mid power



Leisure and entertainment

Requirements

- Small & lightweight system
- Easy to install
- Long autonomy
- No Maintenance
- High reliability
- Weather independent
- Easy to refill
- Low price (except for early adopters)
- Question about consumer safety norms



Drone

Requirements

- Small & **ultra** lightweight system
- Easy to install
- Long autonomy
- High reliability
- Weather independent
- Easy to refill
- **Start/stop at each flight**
- **Regulation not set yet**

○ Portable mid power



Leisure and entertainment

Requirements

- Small & lightweight system
- Easy to install
- Long autonomy
- No Maintenance
- High reliability
- Weather independent
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Drone

Requirements

- Small & **ultra** lightweight system
- Easy to install
- Long autonomy
- High reliability
- Weather independent
- Easy to refill
- **Start/stop at each flight**
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Portable mid power actual solutions

Solar panels + battery



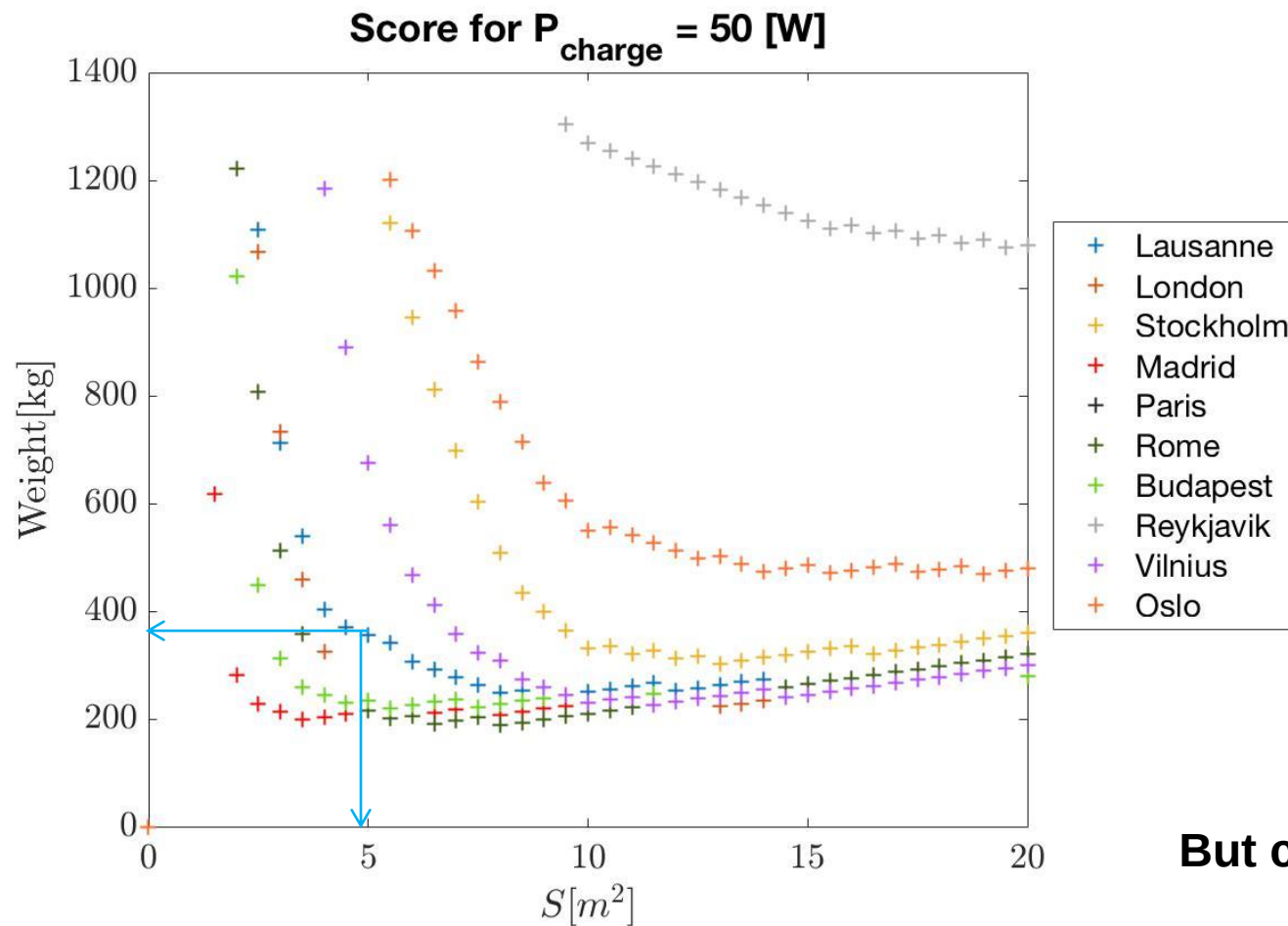
Genset + battery



Other fuel cells



Solar panels + battery



To get **50W (very small laptop)** all the year, a huge installation is required

Even in southern countries

- Of course this is due to winter where solar panels produces only small amounts
- In summer a lot of energy is therefore lost

But could be interesting to combine with fuel cell

Analyze made with real data from different regions

○ Genset + battery



- Installation is heavy
- CO2 emission is high
- Price is relatively higher (auto start genset)
- Noisy
- Maintenance (2x year if runs 10% of time)
- Low efficiency -> big reservoir or a lot of refueling needed
- Problem with charging the batteries because too powerful

3kW genset need 30kW batteries to work 10% of time -> = **600kg batteries**

Other fuel cell companies

SFC Energy



- 424 M€ capitalization
- More than 50k units sold
- Present in all “off-grid” market
- Sell mainly Methanol Fuel cell

Sunfire



- Mainly focused on big electrolyzer
- have one product for “off-grid”
- Heavy 60kg without fuel



Other fuel cell companies

there is competitors

- we can analyze them
- Study their market
- Study the function implemented in their product
- Ask feedback from their customers
- Once we get visible, we can get better traction from investors or being bought by big companies

- We need to be sure that there is still space in this markets
- We must have a better product
- We must be sure they can't copy us fast because they don't need to develop their sales strategy

SFC energy



SFC energy

	EFOY 80	EFOY 150	EFOY Pro 900	EFOY Pro 1800	EFOY Pro 2800	EFOY Pro 12000 Duo	EFOY Hydrogen
							
Max. output ¹	40 W	75 W	42 W	82 W	125 W	500 W	2500 W
Nominal voltage	12/24 V DC		12/24 V DC			24/48 V DC	48 V DC
Weight	6.5 kg 14.3 lbs	6.9 kg 15.2 lbs	6.5 kg 14.3 lbs	7.2 kg 15.9 lbs	7.8 kg 17.2 lbs	32 kg 70.5 lbs	27 kg 59.5 lbs
Dimensions ² L x W x H	448 x 198 x 275 mm 17.6 x 7.8 x 10.8 in	448 x 198 x 275 mm 17.6 x 7.8 x 10.8 in	448 x 198 x 275 mm 17.6 x 7.8 x 10.8 in	448 x 198 x 275 mm 17.6 x 7.8 x 10.8 in	448 x 198 x 275 mm 17.6 x 7.8 x 10.8 in	640 x 441 x 310 mm 25.2 x 17.4 x 12.2 in	536 x 483 x 311 mm 21.1 x 19 x 12.2 in
Connectable fuel cartridges / gas cylinders	1 (up to 8 with EFOY Fuel Manager)		1 (up to 8 with EFOY Fuel Manager)			2 (up to 4 with DCS1)	The system has one connection. Several H ₂ gas cylinders can be connected to each other.
Operating Temperature	-20 °C bis +40 °C -4 °F to +104 °F		-20 °C bis +50 °C -4 °F to +122 °F			-20 °C bis +50 °C -4 °F to +122 °F	-33 °C bis +50 °C -27.4 °F to +122 °F
Fuel	Methanol in EFOY Fuel cartridges		Methanol in EFOY Fuel cartridges			Methanol in EFOY Fuel cartridges	Hydrogen
Performance classes of the EFOY fuel cells	40 W	75 W	42 W	82 W	125 W	3 KW	50 KW
	Temporary applications		Continuous operation			For higher performance	For higher performance

1. The output power decreases with the operating hours.
2. Dimensions without 19" frame. All technical data at test conditions of 20° C.

SFC energy

Technology limitation

- Work only on pure methanol -> must be bought at sfc or direct reseller
- Fuel cell work at ambient temperature without extreme
- Can't work under 0°C without cabinet
- Lose 33% power in 6000 hours (250 days)
- Efficiency is relatively low due to big BOP

Feedback from SFC customers

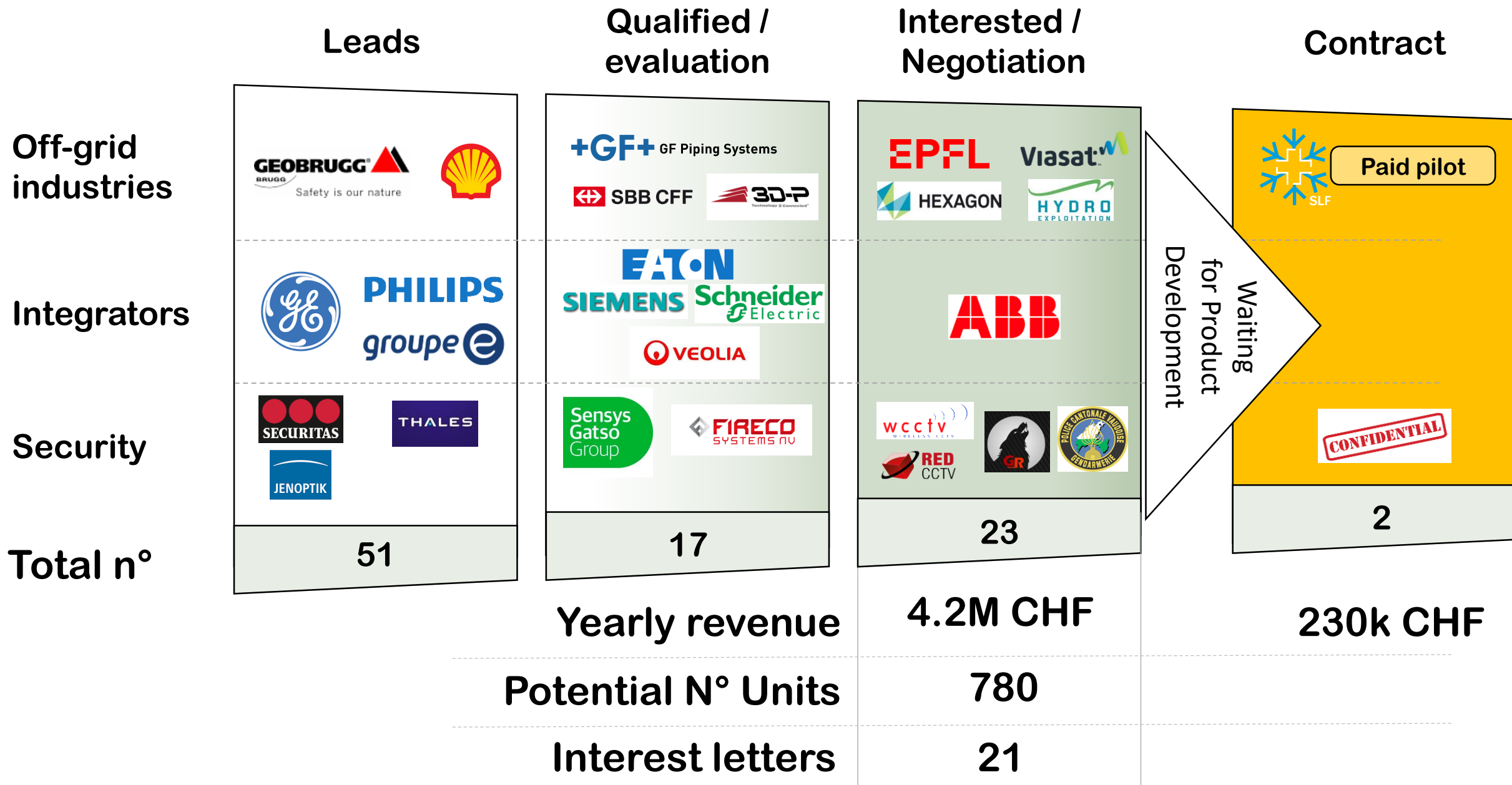
- They would be much happier if they could use commercial fuel
- They don't like the water that flow out of the system.
- Water can freeze and clog in winter
- System is dead too fast

However, They still use this because it's the best solution

Off-grid markets conclusion

-> Off grid markets seems big enough and energy problem is not solved

Client Acquisition and Validated Prospects



Sales strategy

sales channels



Direct sales

- First channel
- High margin / low scalability



Integrators / distributor

- 2nd step after product launch
- 30% distributor margin
- Scalable distribution

+GF+



 SBB CFF

Sensys
Gatso
Group

igemetris
TECHNOLOGIES


swisscom

ABB

 **BOSCH**

PHILIPS

 **VEOLIA**


H2P

Viasat

What are the customers saying?



*"We see a high potential in **fuel cells** for our systems, as they are clearly superior to diesel generators in terms of maintenance and energy efficiency. [...] We are very interested in a system allowing harsher environmental conditions [compared to SFC products], using available fuels."*

Geopraevent, Zürich, Switzerland



*"Fuel cell is becoming a standard in mobile CCTV systems as they give very good operational flexibility. **We're targeting 200-400 units per year using fuel cells.** SFC is an issue because of the dependence to their fuel (methanol) and lifetime. If INERGIO reaches 8-10k hours with a power loss under 20-30%, you're definitely into the game."*

WCCTV, Rochdale, UK



*"We have a strong interest in your product to power our surveillance systems in places without electricity. We have some units from SFC but we have a problem with **the high quantity of water at the exhaust** and also **availability of the fuel**, we are potentially looking for 5-6 canton Vaud only"*

Police Cantonale Vaudoise, Lausanne, Switzerland

Market potential

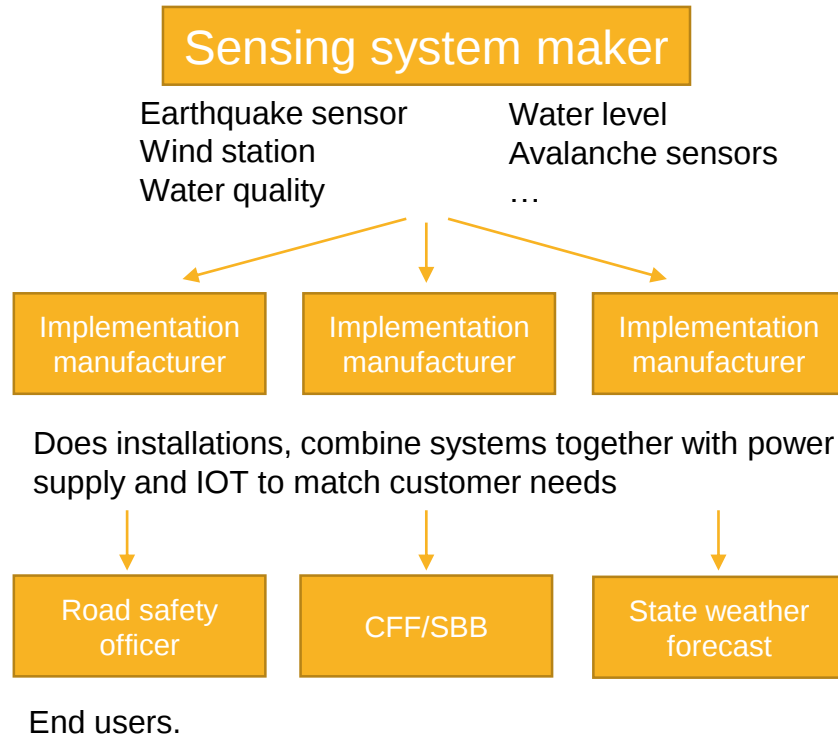


Power (W)	Current focus	Consumer & leisure	Autonomous robotics	Auxiliary and backup power
	Off-grid industries			
25 - 100	✓	✓		
200-600	✓		✓	✓
N° of units	105'000	165'000	66'000	93'000
Yearly SAM [CHF]	1'000 M	700M	760M	1'800M
Go to market	2021	2023	2025	2026
Leads	58	12	7	
Lols	19		2	

+430'000 units

+4.2 Bn CHF

“off-grid” – Sensing market structure



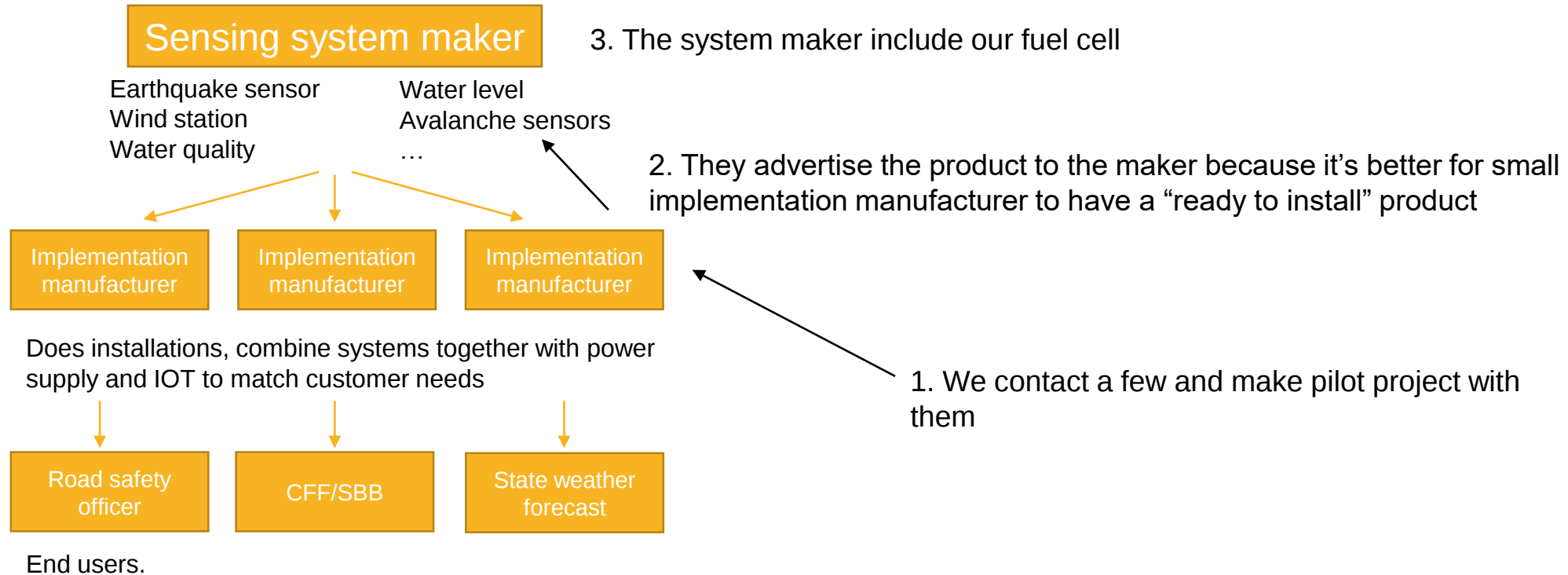
← Big companies. Hard to reach
Don't want to take risks with new tech

← Know the problems but they are a lot.
Require a big sale force

← Don't know the problems, they just
want a system running



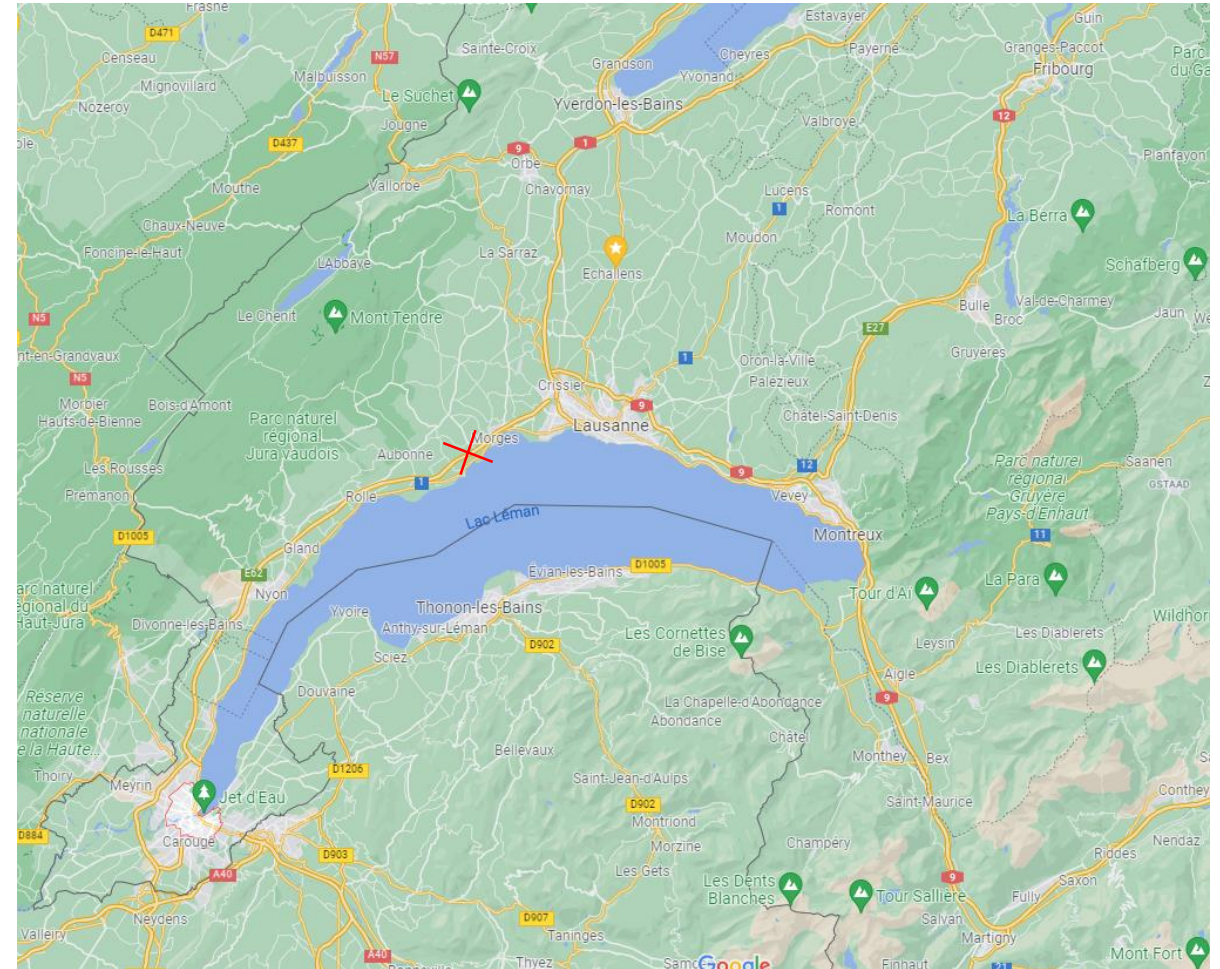
“off-grid” – Sensing market structure





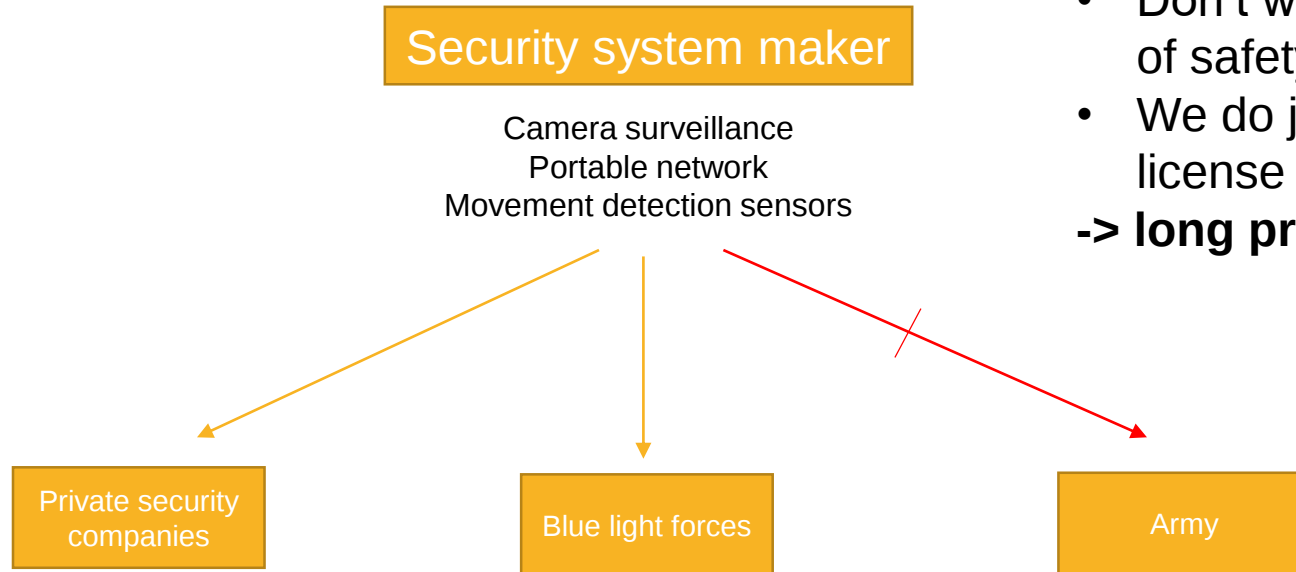
“off-grid” – Example

- Hole on the rails between Geneva and Lausanne
- No train for 2 day, perturbation for weeks
- 60k peoples travel everyday
- 20 worker, a provisory bridge were needed



Normally sensor are placed on tracks during construction. But often the get shut down because of not reliable power supply

“off-grid” – Security defense



- Very big companies
 - Don't want to buy full system to a startup because of safety (hacking on electronic)
 - We do join project, deliver only the main part and license the BOP
- > long process but can be paid project**

○ “off-grid” – ideal strategy

- Start paid projects with security market
 - > **finance our research**
- In parallel we make pilots with small customers to validate our product
- The bigs see our validation and start to buy
- Paid project start to get finalized and security market get opened
- Investigate leisure market
- Step in drone market when emerging

-> our business team will grow from 2022



Thank you