

Datalogging, power electronics and machine learning: how ERIGRID has kick-started my research on perpetual development in microgrids

Open tools for building energy from the bottom-up

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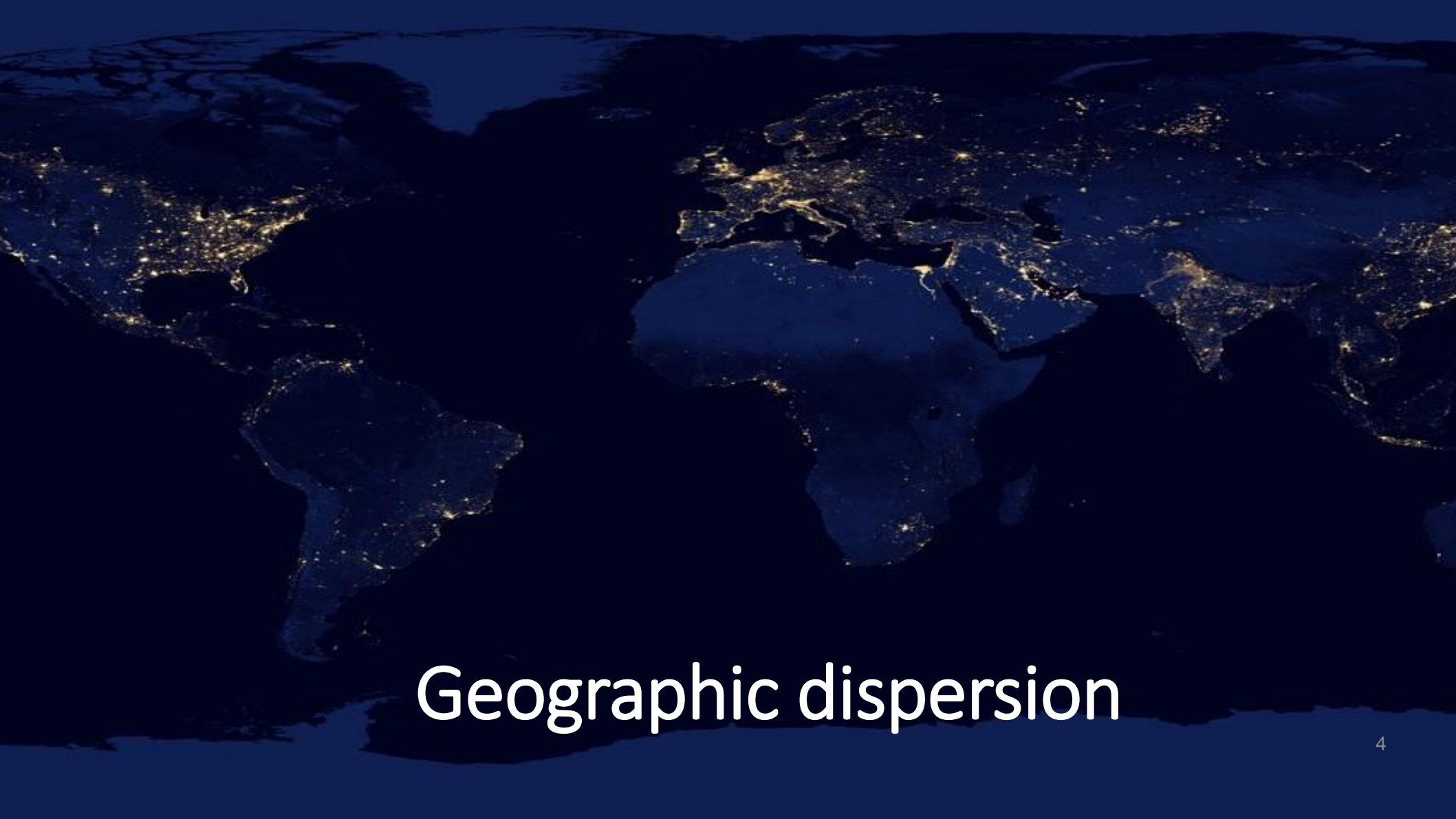
ERIGRID Final Event – April 1st 2020

Summary

- Introduction
- Perpetual development
- Tools for perpetual development
- Conclusions

One billion





Geographic dispersion



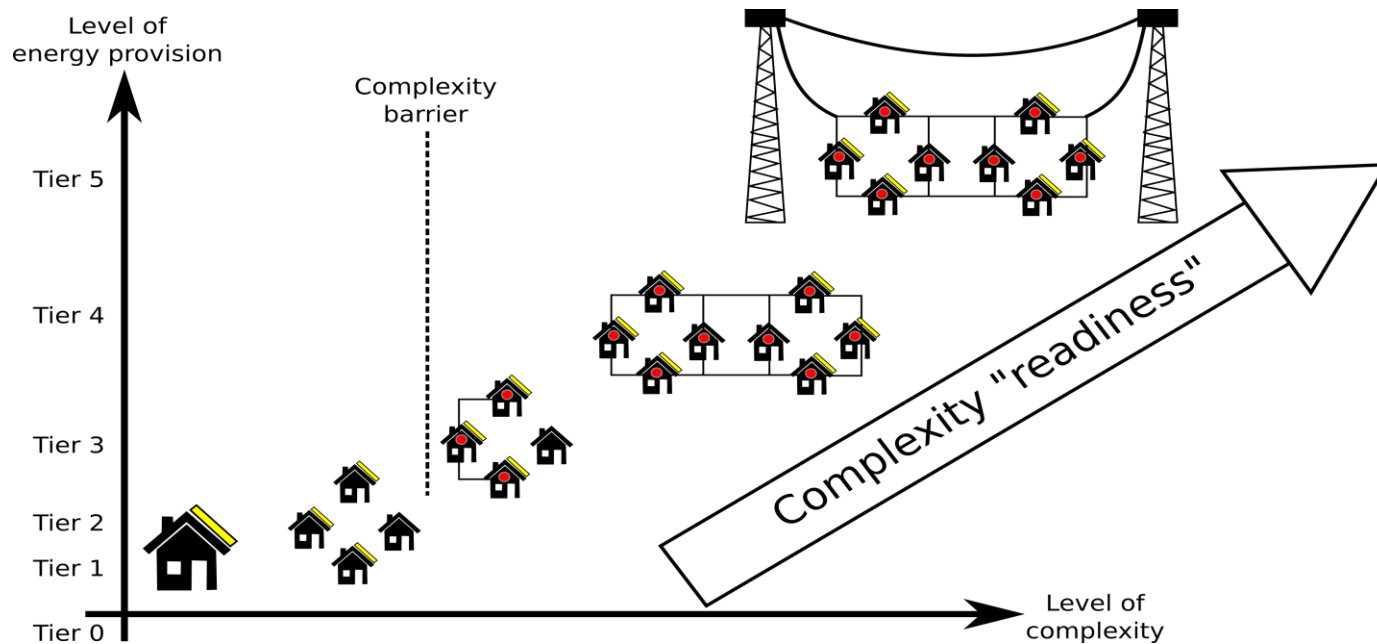
Diversity of
sources



Cultural diversity of uses



Energy Access Theory – Swarm Electrification

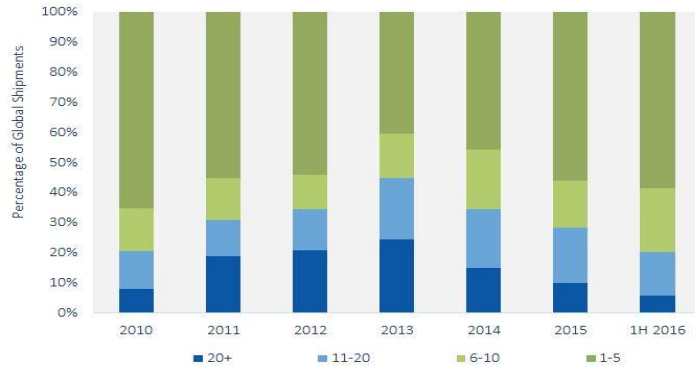


Groh, S., & Koepke, M. (2015). A system complexity approach to swarm electrification. UCL STEaPP.

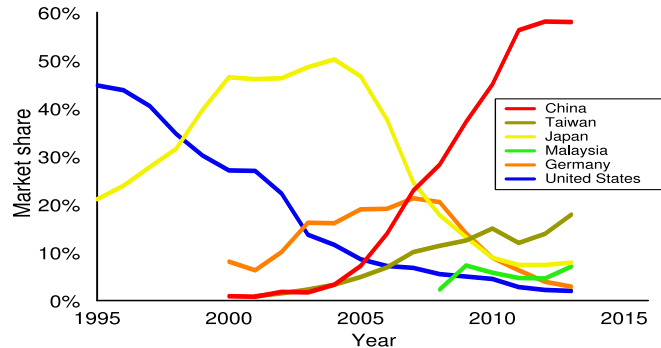
Solutions are tier specific ...



... and generate industrial dependence

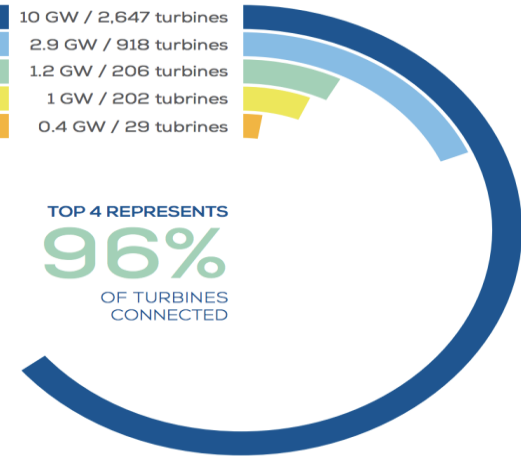


Market Share of Photovoltaic Cells



Wind turbine manufacturers' share at the end of 2017

Siemens Gamesa Renewable Energy	10 GW / 2,647 turbines
MHI Vesta Offshore Wind	2.9 GW / 918 turbines
Senvion	1.2 GW / 206 turbines
Adwen	1 GW / 202 turbines
Others	0.4 GW / 29 turbines



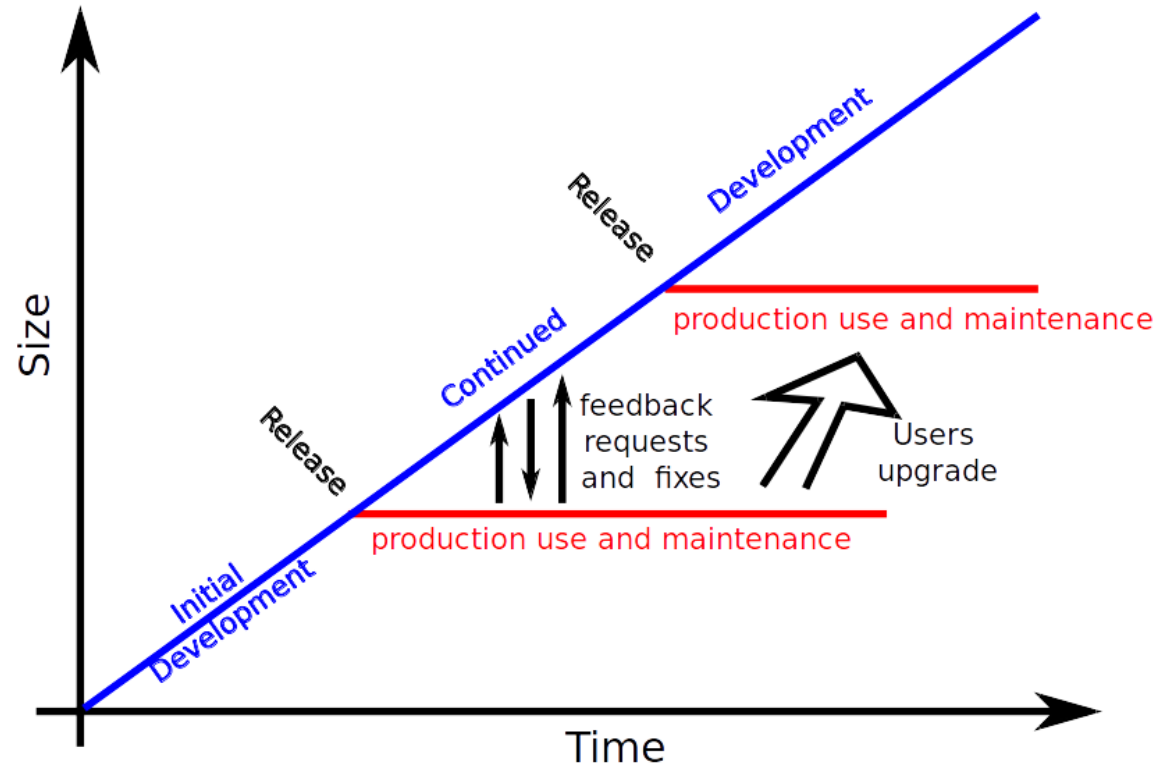
Source: WindEurope

How can we create multi-tier micro-grids that guarantee technological independence and provide affordable electricity?

By creating tools to implement open perpetual development in micro-grids

By creating tools to implement open
perpetual development in micro-grids

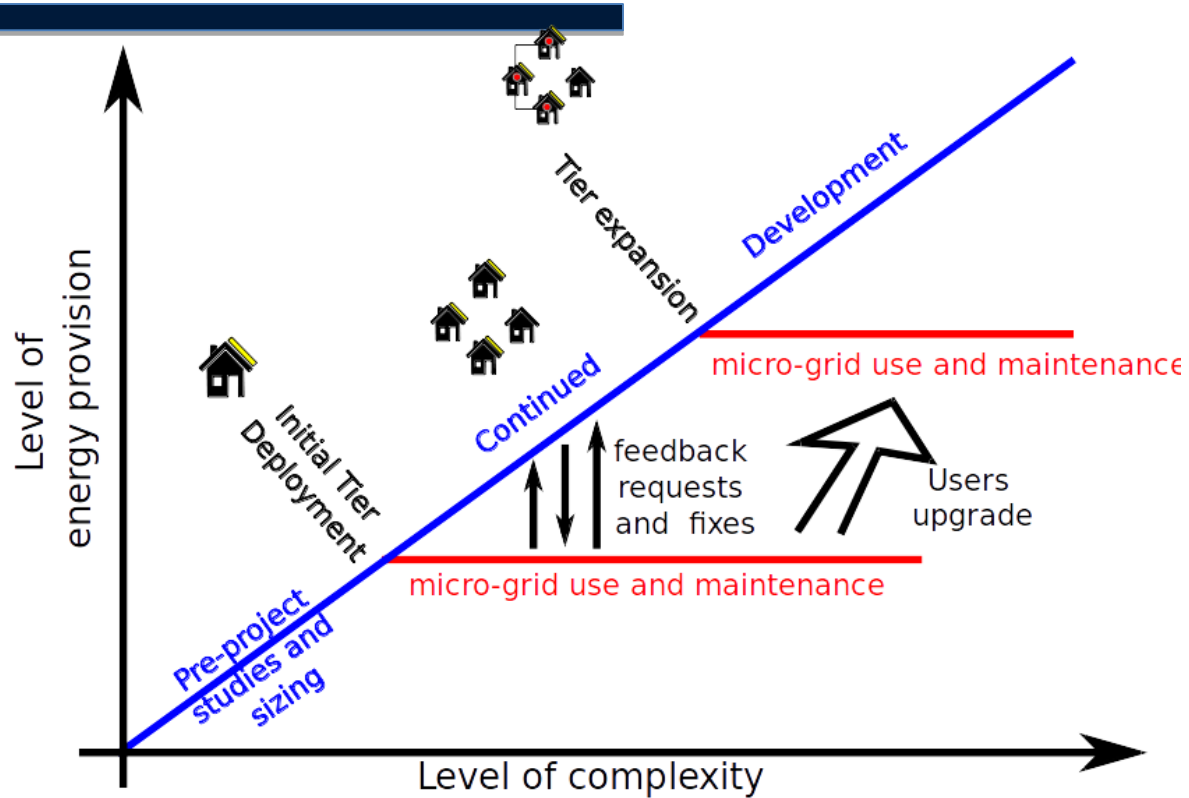
Perpetual Development - Linux



Dror G. Feitelson, *Perpetual development: A model of the Linux kernel life cycle*, Journal of Systems and Software, Volume 85, Issue 4, 2012

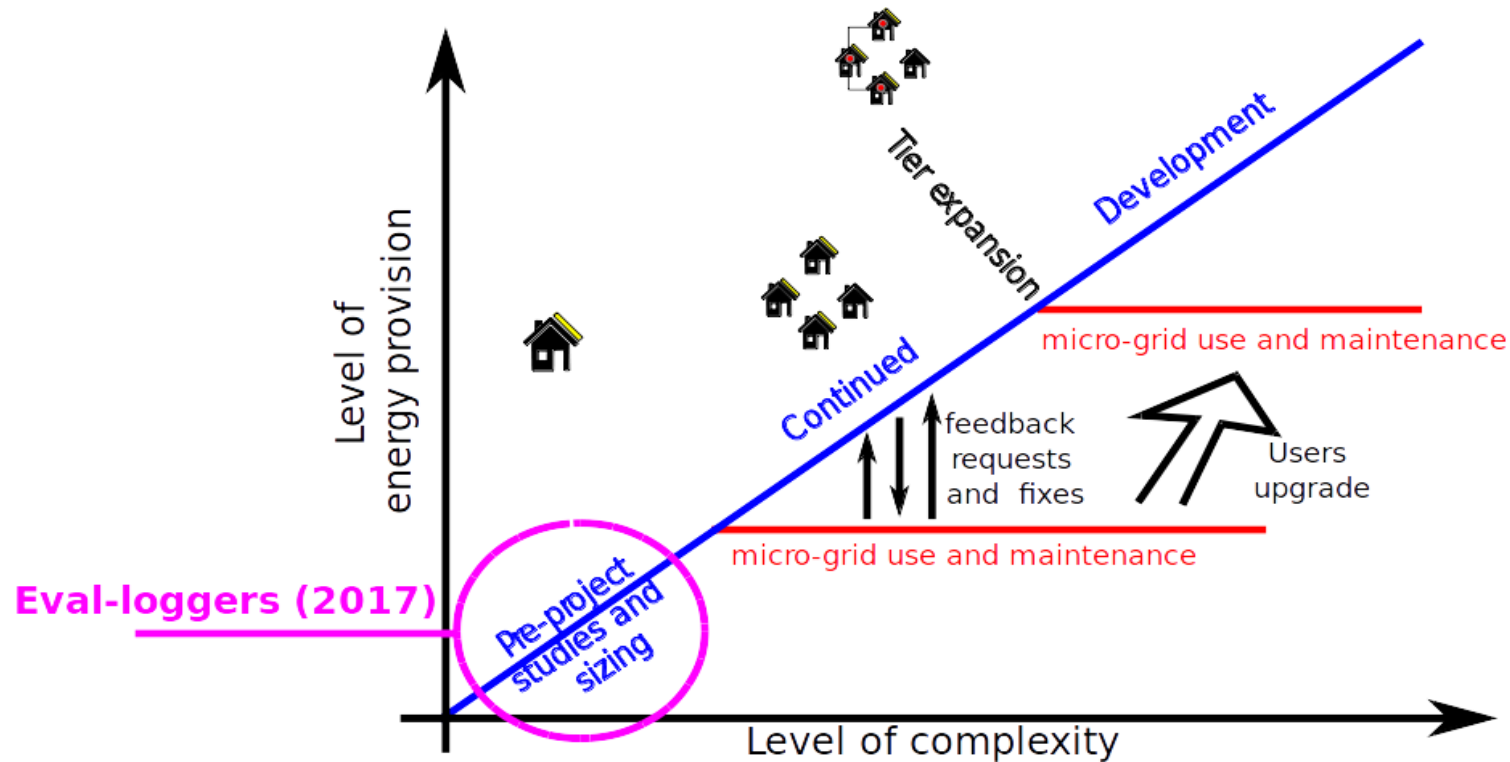
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Perpetual Development – Micro-grids



By **creating tools** to implement open perpetual development in micro-grids

Perpetual Development – Tools



Pre-study – Eval-loggers project



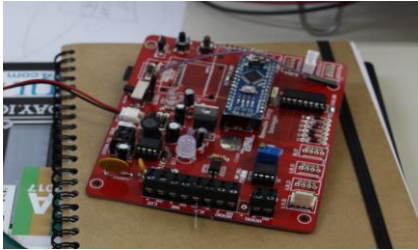
RÉSEAU TRIPALIUM



- Participants

- Host

Eval-loggers – The dataloggers

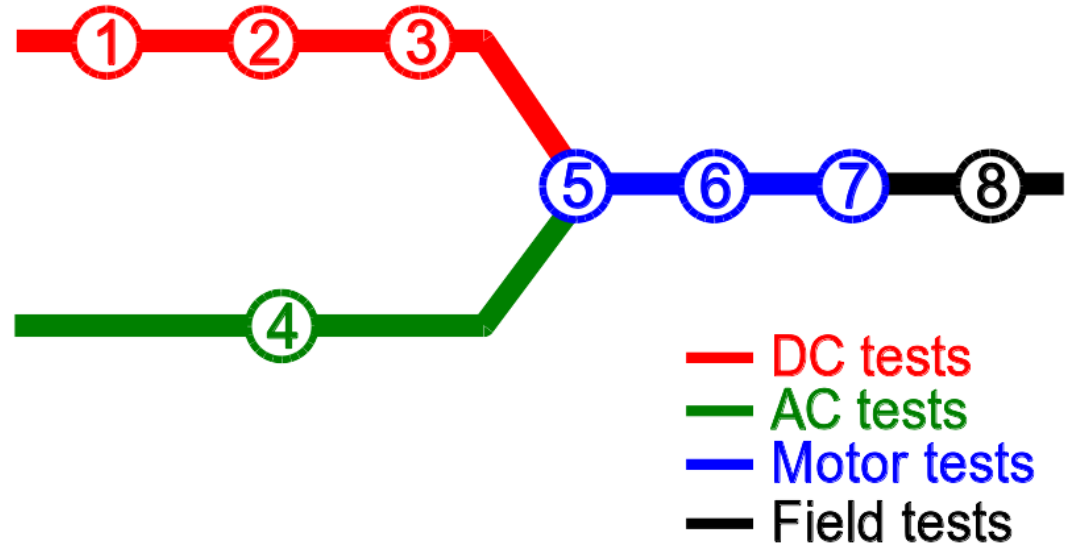


- Low energy logger



- Modular

logger



Study – Test photos

- Motor test



- DC test



- AC test

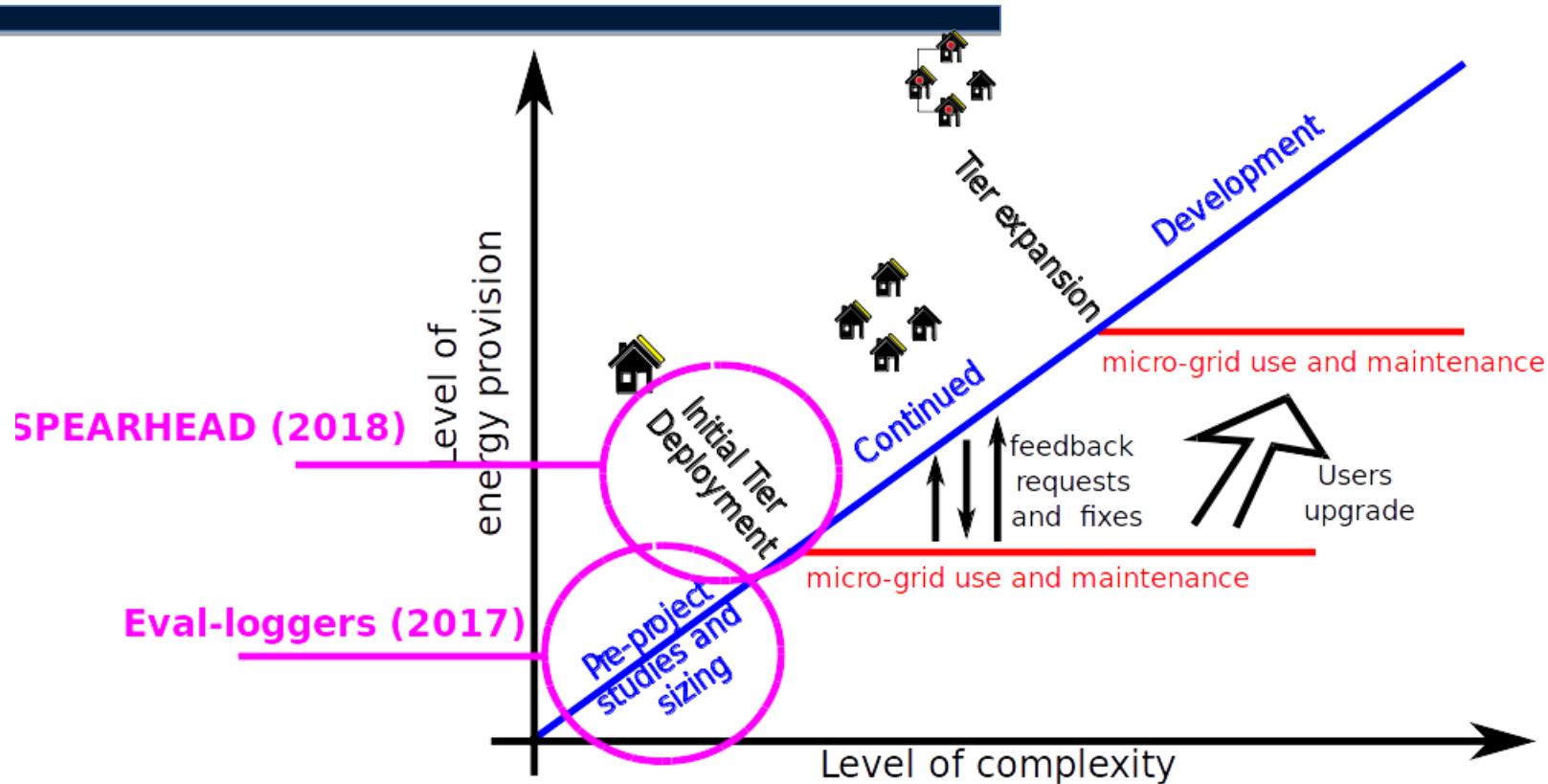


- Field test

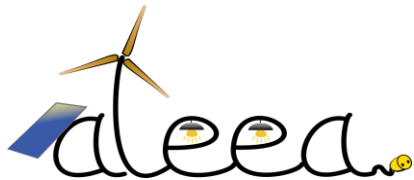
Study – Main results

- **Low-cost but high efficiency!**
 - Calibrating the datalogger with a 50€ multimeter yielded the same result as calibrating with a 100k€ equipment
- **Aesthetics is important**
 - We realized that having a user-friendly GUI would help a lot in the future
- **Improvements**
 - A long list of improvements emerged from the discussions and the testing results

Perpetual Development – Tools



Deployment – SPEARHEAD project

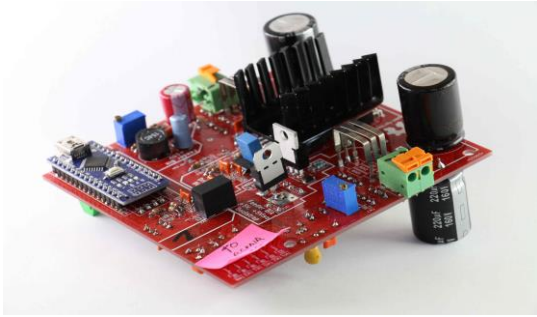


- Participants

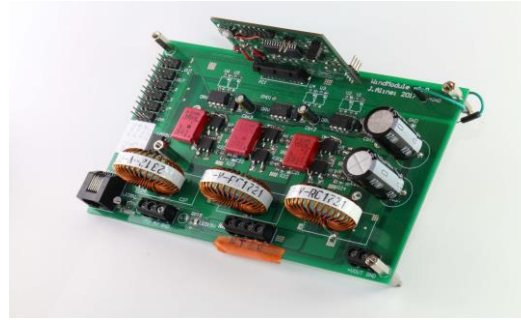


- Host

SPEARHEAD – Power converters



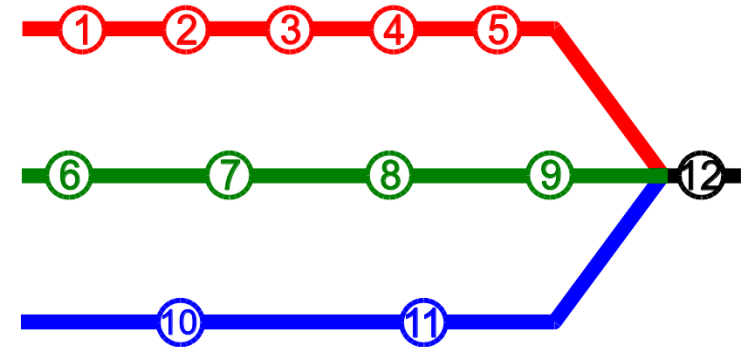
- DC-DC board



- DC-AC board

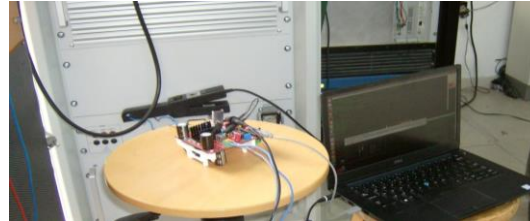
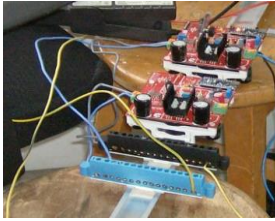


- Motherboard

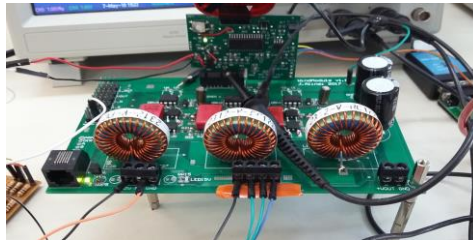
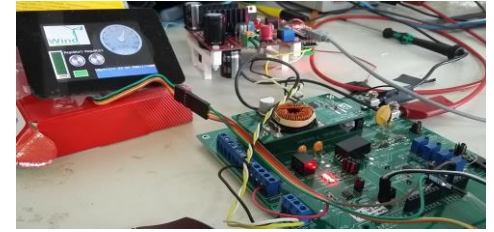


— DC/DC tests
— DC/AC tests
— Motherboard tests

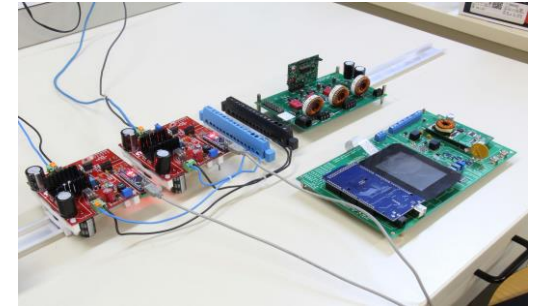
SPEARHEAD – Test photos



- DC-DC board



- DC-AC board

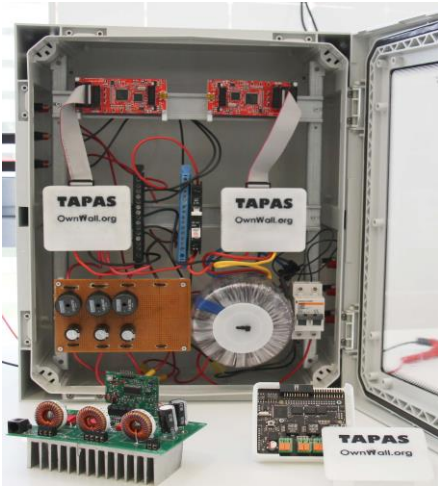


- Motherboard

SPEARHEAD – Main results

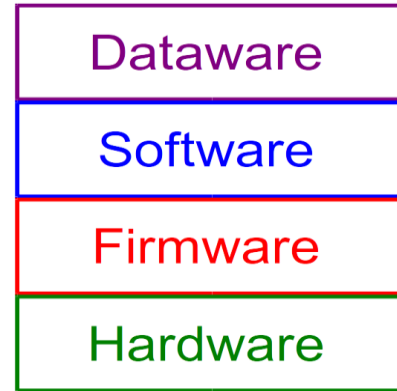
- **DC-DC conversion algorithms validated**
 - PV MPPT, battery charging and half-wave AC were all implemented and validated
- **DC-AC conversion was more complicated**
 - The DC-AC board needed many improvements before being operational
- **Vision of the “Power Stack”**
 - A new vision of the power converter as a key enabler of the micro-grid was crystallized via a “power stack”

SPEARHEAD – What happened then?

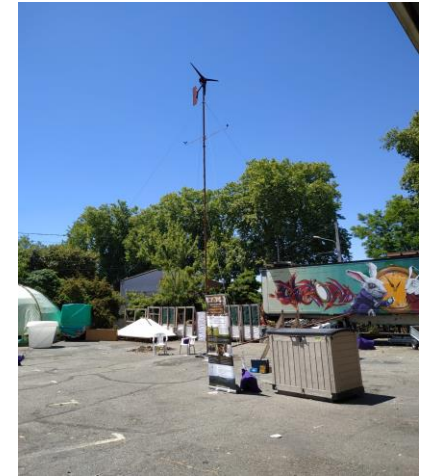


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- 2 place at the Siemens TAPAS challenge

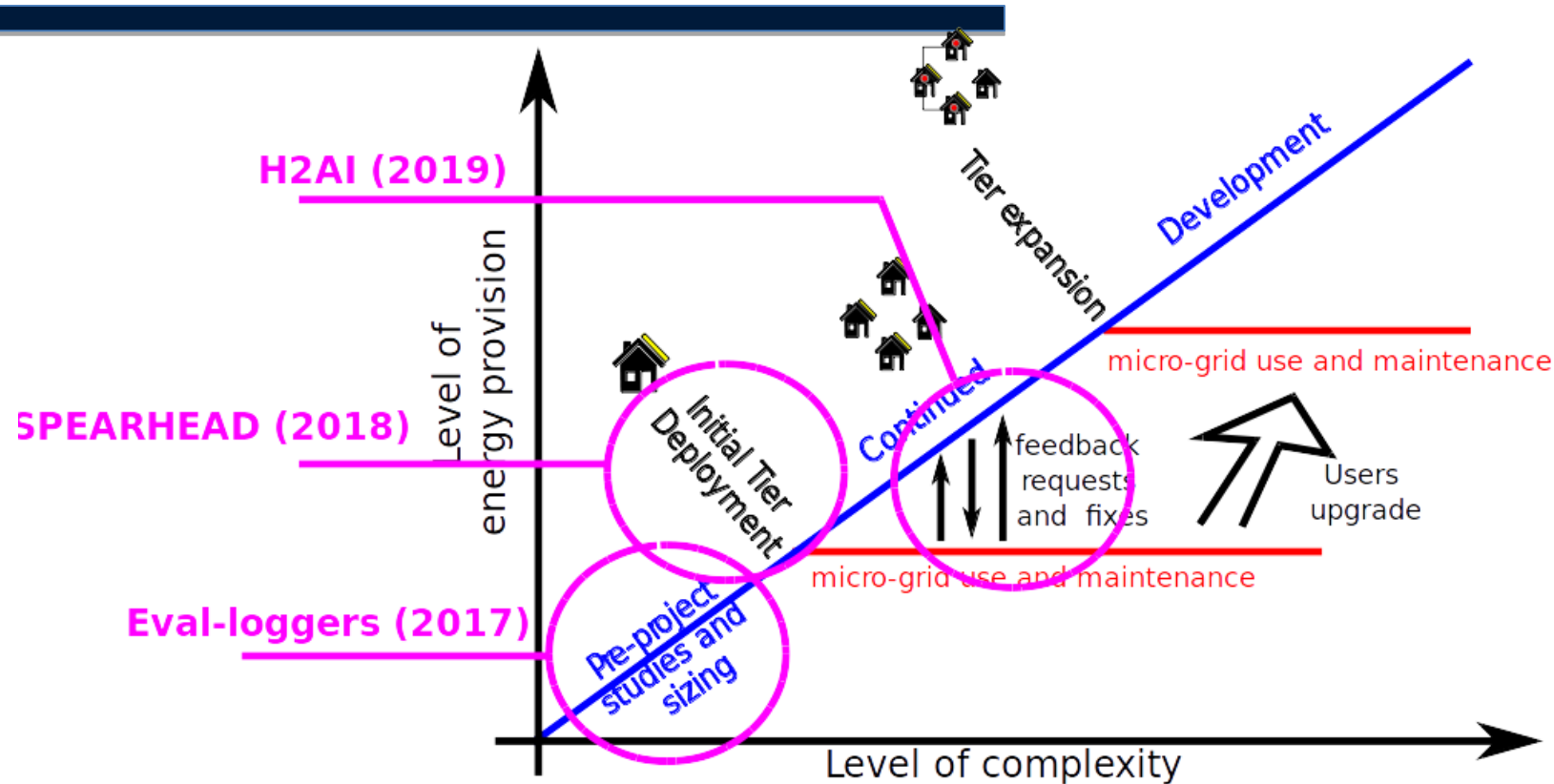


- Formalization of the power stack



- Creation of a local micro-grid

Perpetual Development – Tools



SPEARHEAD – Main results

- **DC-DC conversion algorithms validated**
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Feedback/Operation – H2AI project



- Participants

- Host

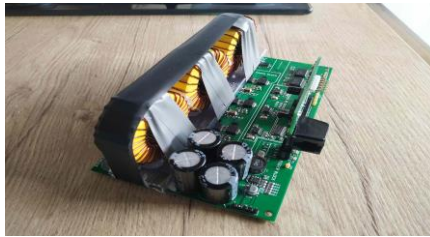
H2AI – Water pumping & AI (Data)



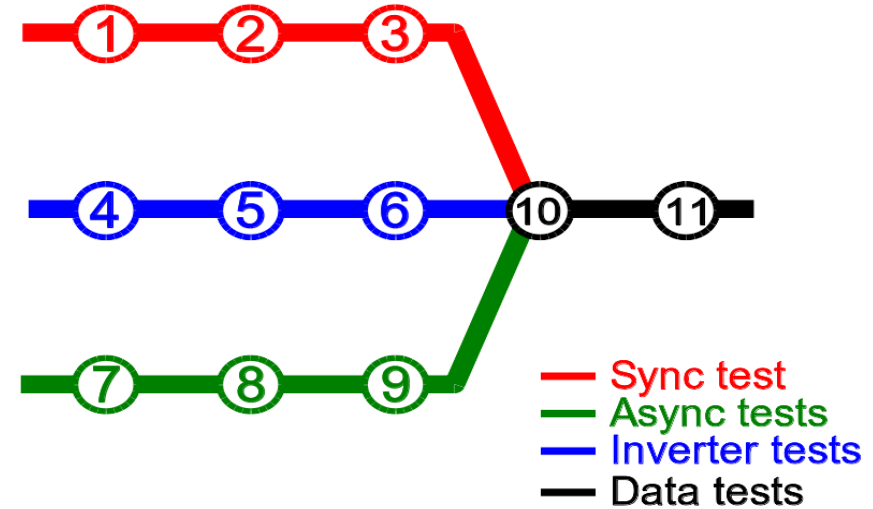
- Async motor



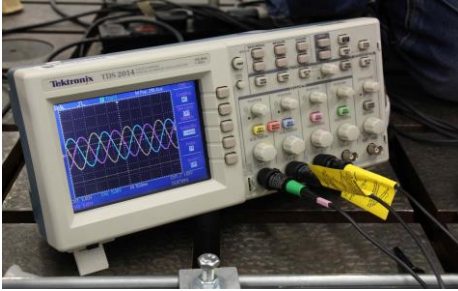
- Sync motor



- 3-phase inverter



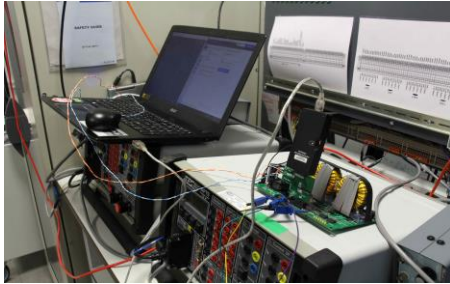
H2AI – Test photos



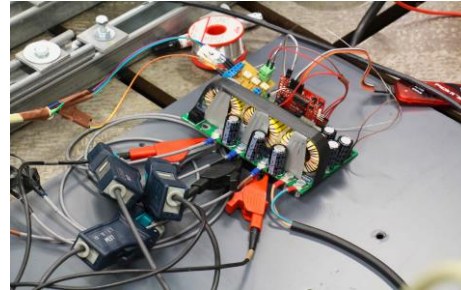
- 3-phase wave



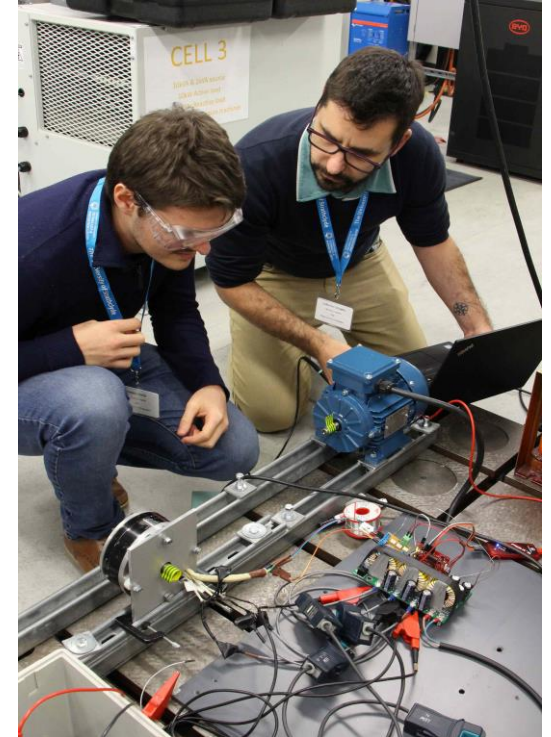
- Async test



- Inverter test



- Sync test



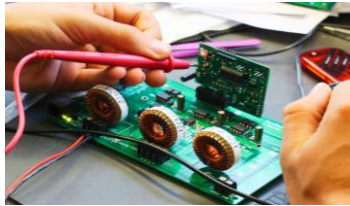
- Test bench

H2AI – Main results

- **DC-AC conversion algorithms validated in open-loop**
 - V/f, 6-pulses and vectorial control have been tested in open-loop and have worked
- **Data acquisition issues tracked and solved**
 - The DC-AC board had an unforeseen issue with its data acquisition chain. It was solved.
- **Vision of the “Power Kernel”**
 - The project tested and validated 3 different algorithms which were coded in three distinct ways. This validated the notion of “Power kernel”.

By creating tools to implement **open**
perpetual development in micro-grids

Open-source licenses



Maintenance



Development



Education



Installation



Operation

Conclusions

- **We are more than happy to ship you a power kernel**
 - The OwnTech project will build dozens of new versions of the power kernel. Let us know after the presentation if you want one!
- **Everything is already open-source**
 - The schematics, routing and firmware code of the current version of the power kernel is already available online at our git page
<https://redmine.laas.fr/projects/owntech>
- **We'll see each other soon**
 - There's still plenty of room to cover in the perpetual development cycle. We will see each other again for another TA to test the next phase of our project's development

Merci beaucoup!
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