INTRODUCING
ENERGY FLEXIBILITY

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THE ENERGY TRANSITION DILEMMA

Basic reasoning:

1 - Reduce energy usage
2 - Use renewable/green energy
3 - Other options (like fossil fuel)

But:

1 - Can reduce the amount of flexibility
1 - Introduces energy peakdemand (when renewable energy is not available)
2 - Wind and solar are uncontrollable but predictable
2 - Storage and conversion technology necessary
3 - Still hinging on fossil fuel options
THE NEED FOR ENERGY-FLEXIBILITY

- Until now, introducing renewable energy is most important
  - In the future, absorbing/using renewable energy is even more important
- Transition to facilitate the transition
  - From ‘demand driven’ ➔ towards ’supply following’
  - Use renewable energy for non-time-critical applications
- Fine-grained control of energy-consumption instead of coarse-grained control of energy-production
- Increase inherent system stability
- Reduce peak-loads on TSO/DSO grids
UTILIZING FLEXIBILITY

› Utilize energy-flexibility of non-time-critical applications/equipment
  › E.g. heating/cooling equipment, electric vehicles etc.
› Energy-flexibility has market-value
  › Utilisation of consumption control, storage and conversion technology
› An energy-flexibility market ➔ subject to ‘normal rules for an open market’
  › Many market players utilising end-user energy-flexibility
    › Energy service companies, aggregators, suppliers, DSO’s
› Freedom of choice for end-users providing flexibility
  › SME’s, office-buildings and households
CURRENT SITUATION

Disadvantages:
- Costly and complex
- Switching is difficult
- Proprietary solutions
- Customer lock-in
FLEXIBLE USE OF ENERGY-FLEXIBILITY

› Open energy market ➔ freedom of choice for end-user

› In three dimensions:
  › Energy equipment purchase
    › No vendor lock-in
  › Energy management / optimization applications
    › Adapt to energy-system changes and regulations
  › Energy Service Providers / Flex-aggregators
    › Switch between different ESP’s (e.g. join local energy initiative)
ENERGY FLEXIBILITY INTERFACE

- **Cost-effective**
- **Open Source**
- **Easy switching**
- **No Lock-in**

International Certification Process:
- FAN joined CENELEC working group CLC/TC 205/WG18, Home and Building Electronics Systems
- EFI principles are in high level architecture (CENELEC EN 50491-12-1); now in voting
- EFI details to be proposed for 2nd guideline (CENELEC EN 50491-12-1); in drafting
WHAT IS THE EFI?

- An interface for communicating only energy flexibility and its allocation
- EFI messages are about a single device; no aggregated info
- Lightweight: minimal amount of information to describe flexibility
EFI ENERGY FLEXIBILITY CATEGORIES

The EFI categorizes Energy Flexibility in four different types:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
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<td>Photo-voltaic panels, domestic</td>
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<td>loads, ...</td>
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<td>Time shiftable</td>
<td>Process which can be shifted in time, e.g. has a deadline.</td>
<td>Washing machines, dish washers,</td>
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<td>Output Adjustable</td>
<td>Flexible in production / consumption level and not constrained by a buffer</td>
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FLEXIBLE POWER ALLIANCE (FAN)

- FAN driving force behind EFI

- Whitepaper, documentation, specification, software and source code all freely available online at http://flexiblepower.github.io

“Things should be as simple as possible but not simpler.” - Einstein
ENERGY FLEXIBILITY INTERFACE

BACKGROUND INFORMATION
WHAT IS THE EFI?

- An interface for communicating only energy flexibility and its allocation
- EFI messages are about a single device; no aggregated info
- Light weight: minimal amount of information to describe flexibility
EFI CONCEPTS

- Abstract description of flexibility; device specific details are hidden
- Incentive free; technical flexibility only
- As simple as possible
  - The least amount of assumptions of what an ‘Energy App’ wants to do with the available energy flexibility
- Event driven: Push messages

Smart Grid → Energy App → Driver → Device

Incentives → Aggregation
User control / Comfort Range
Control Space Allocation

04 September 2015 Energy Flexibility Interface (EFI)
ENERGY FLEXIBILITY INTERFACE (EFI)

- **Energy app point of view**
  - Flexibility interface should be relatively simple to understand by smart grid service developers
  - Implementation details of appliance drivers should remain hidden

- **Appliance driver point of view**
  - Flexibility interface should describe potential flexibility of a device as close as possible
  - Does not need to know about the energy app logic, only interested in the resulting allocation
  - "Things should be as simple as possible but not simpler." - Einstein
FROM ELECTRICITY-ONLY TO HYBRID ENERGY

› EFI already handles the additional commodities gas and heat
  › Highly relevant for devices such as Combined Heat Power systems and heat pumps

› Developed within EIT-ICT labs project HEGRID
  › Partners: Alliander, CWI, KIT, University of Twente, VTT, Siemens, TU/e, TNO, Deutsche Telekom
EFI provides one common language for energy flexibility. This allows all smart appliances to communicate with all Demand Side Management solutions without having to develop custom adapters/drivers for each combination.
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FLEXIBLE POWER ALLIANCE NETWORK (FAN)

- Alliance of companies and institutions that jointly develop FAN standards
- Driving force behind EFI, EF-Pi and PowerMatcher
- Open source reference implementation
- www.flexible-energy.eu
COLLABORATION

Starting collaboration with:
- Universal Smart Energy Framework (The Netherlands)
- Fraunhofer (Germany)
- NREL (USA)
- PNNL (USA)

Partners working with our technology:
EXAMPLE PROJECTS

› **ESC**
  ‣ Self sustained apartment buildings in Cologne, Germany
  ‣ Combination of EFI and PowerMatcher
  ‣ PV and heat pumps

› **Lochem**
  ‣ Combination of EFI and PowerMatcher
  ‣ Balance EV charging and PV production

› **HEGRID (European project for hybrid energy management)**
  ‣ Combination of EFI and TRIANA (planning algorithm)
  ‣ CHP’s, hybrid heat pumps, PV

› **HeatMatcher**
  ‣ Combination of EFI and HeatMatcher
  ‣ Heat pumps, floor heating, hot water buffers, solar collectors, PV, ground sources

› **Student project matching OpenADR messages to EFI**
CONCLUSIONS

- Demand Response technology is a necessary component in our future power grid.
- Connecting (smart) appliances to Smart Grid services is currently an obstacle for large scale deployment.
- Enabling technology and standardization in communicating energy flexibility is key to the large scale deployment.
- We believe widespread adoption of EFI would accelerate the deployment of Demand Response technology.
- Whitepaper, documentation, specification, software and source code all available online at http://flexiblepower.github.io