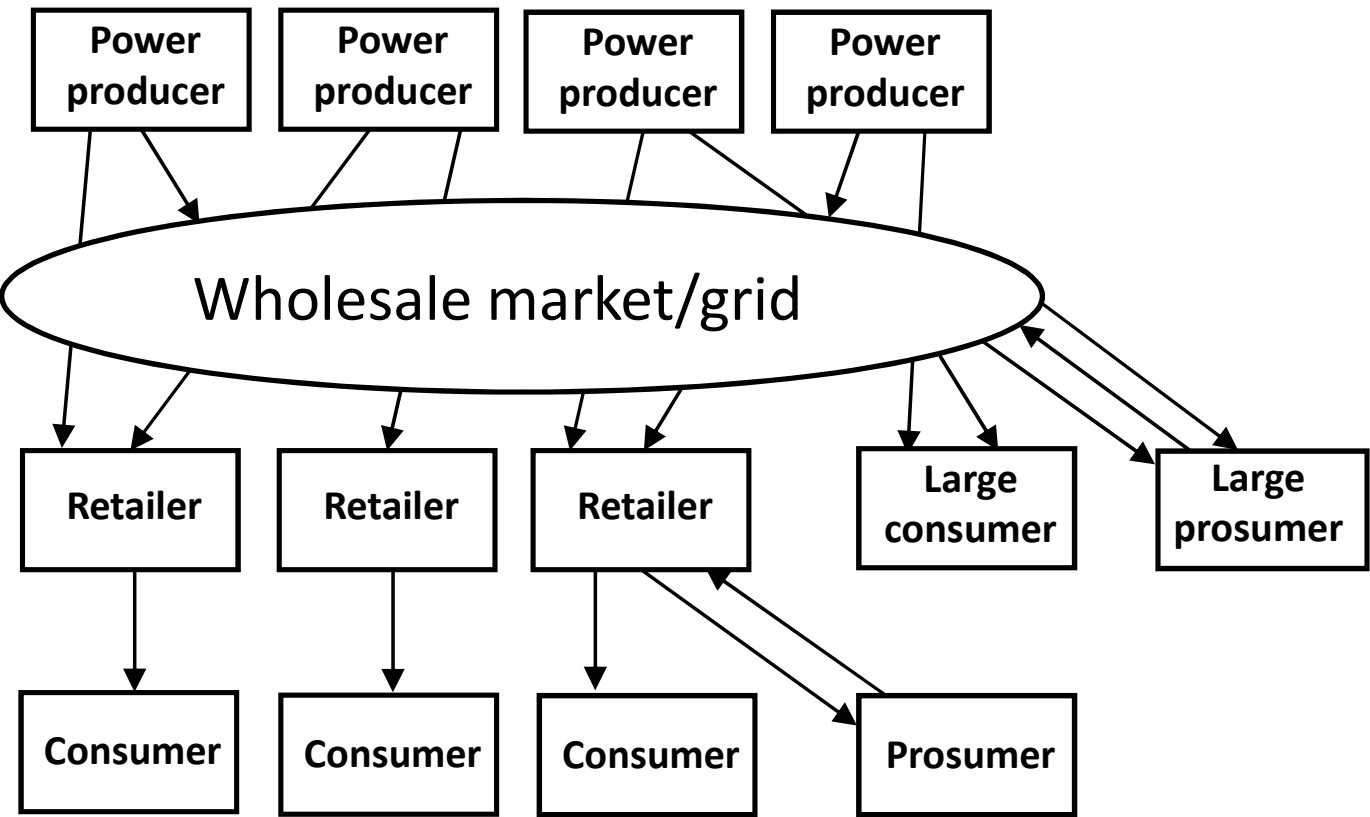


Uber-like Models for the Electrical Industry

Prof. Damien ERNST





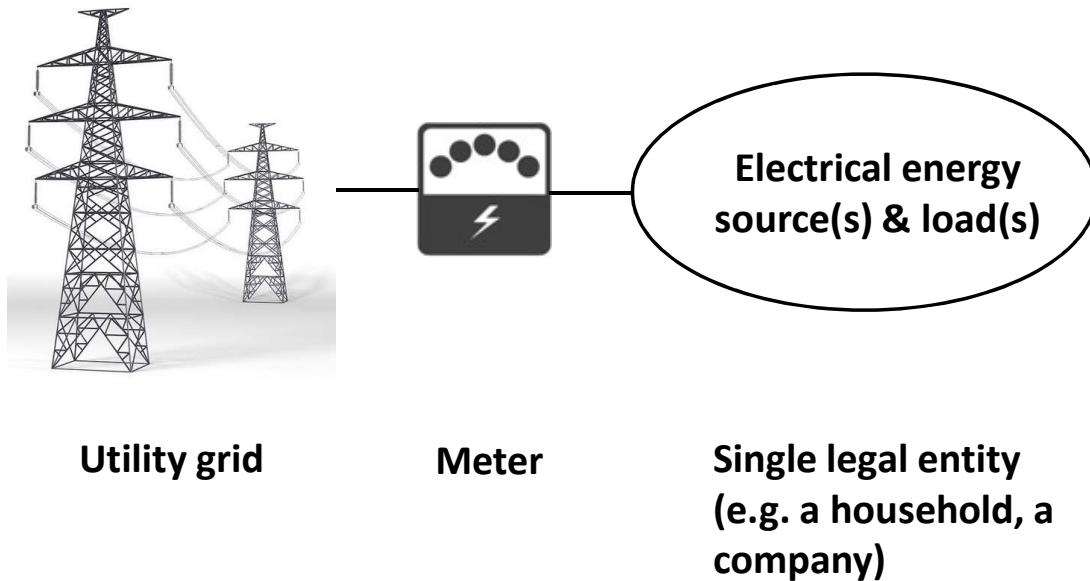
→ Electrical energy sales

Uber-like models for electricity: a definition

Electrical energy consumed by loads that does not go (only) through the electrical energy sale channels defined by →

Microgrids: the most popular uber-like model

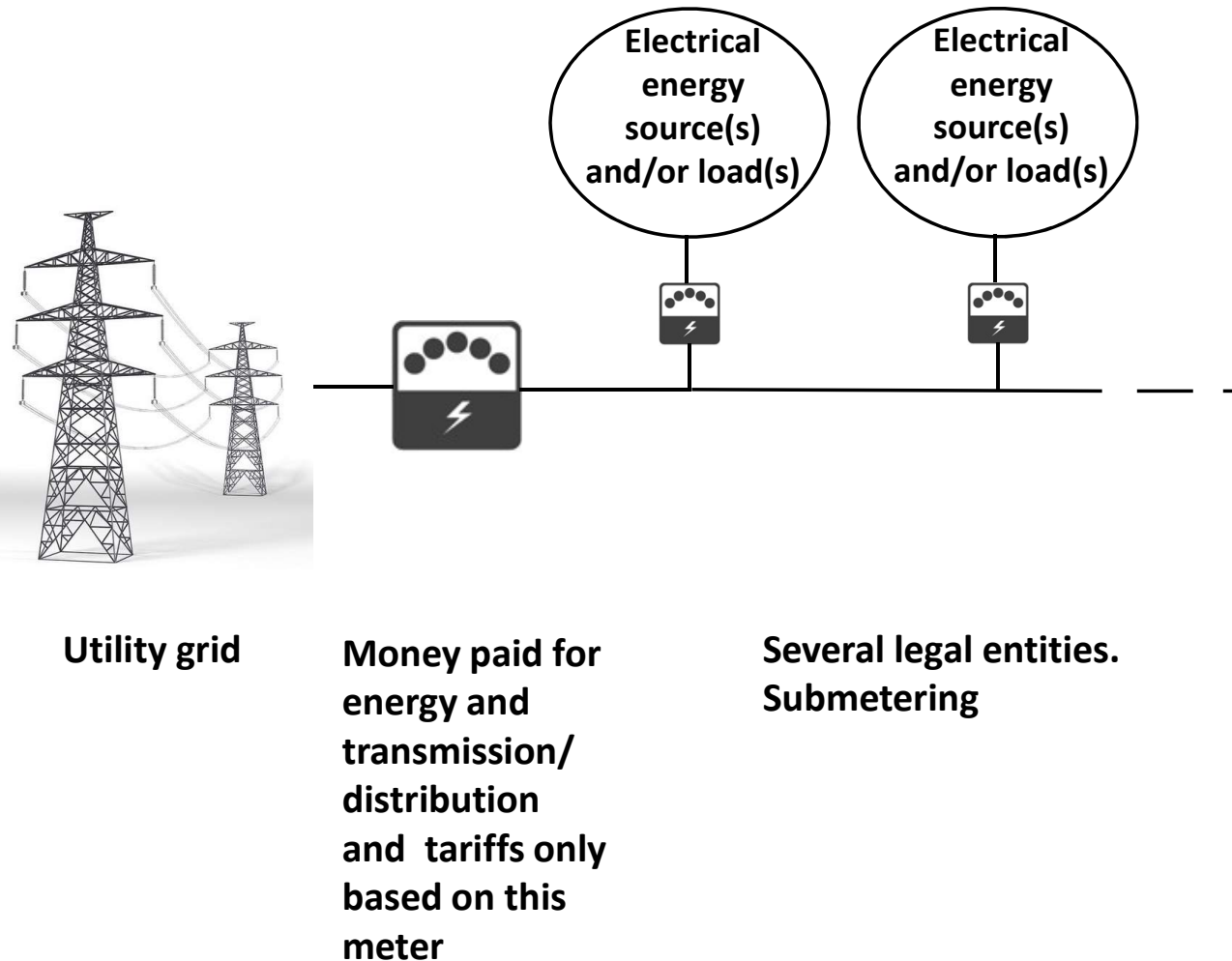
A **microgrid** is an electrical system that includes one or multiple loads, as well as one or several distributed energy sources, that are operated in parallel with the broader utility grid.



The single-user microgrid

1. Legal.
2. Popularised by PV panels and batteries.
3. Possibility to have a microgrid fully disconnected from the utility grid.

The multi-user microgrid

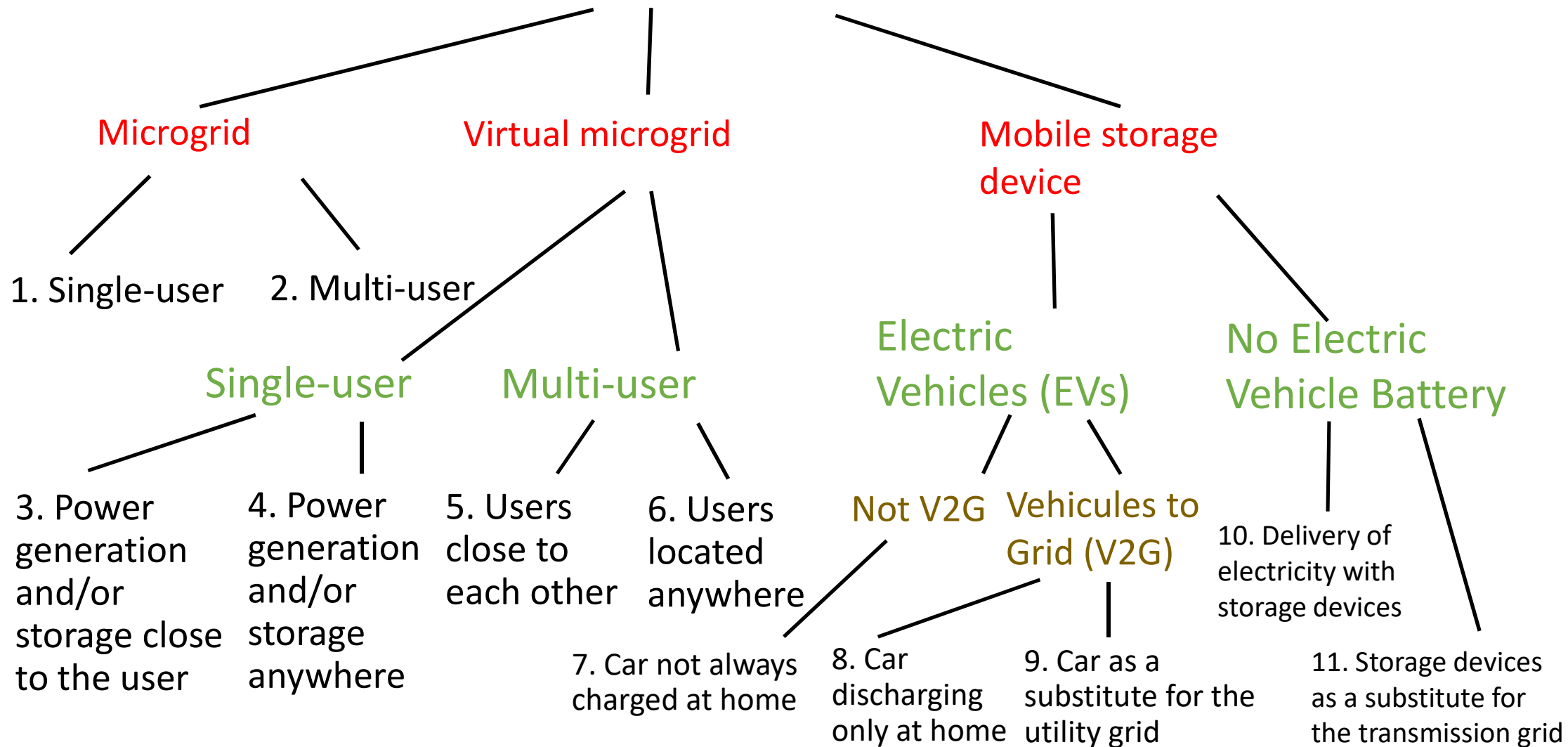


1. Regulatory framework may not allow for the creation of multi-user microgrids.
2. Often more cost-efficient than the single-user microgrid (e.g. economy of scale in generation and storage, easier to get higher self-consumption at the multi-user level).

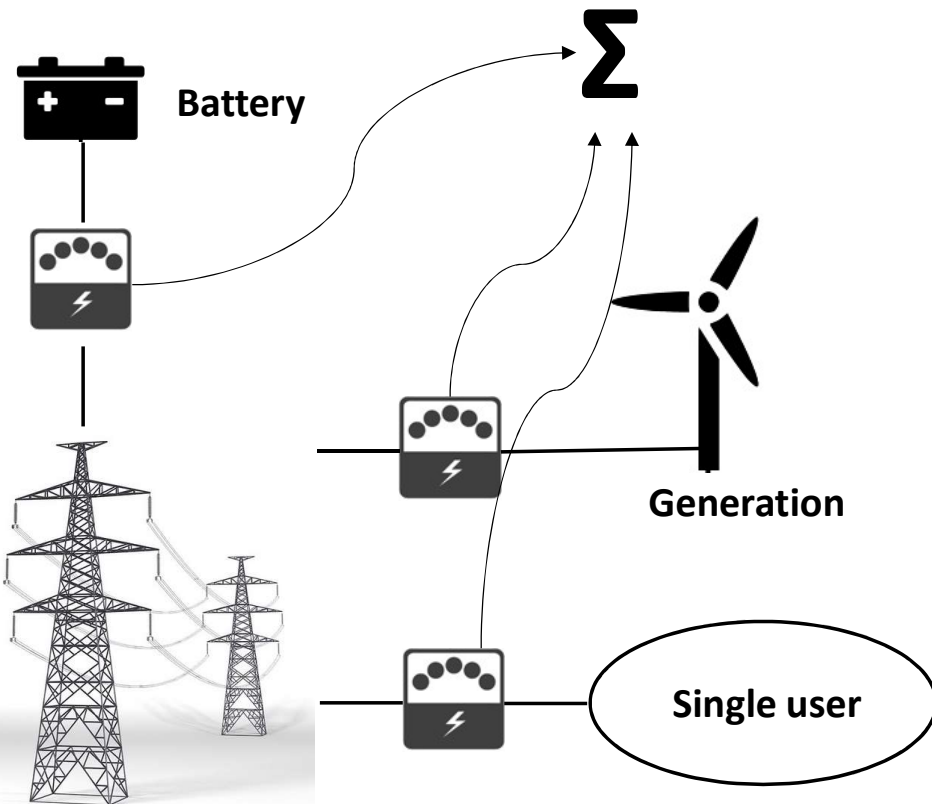
Why microgrids?

- 1. Financial reasons:** (i) Price paid for generating electricity locally is lower than price paid for buying electricity from the utility grid (ii) Hedging against high electricity prices.
- 2. Technical reasons:** (i) Microgrids – especially multi-user ones – are a great way for integrating renewables into the grid and developing active network management schemes (ii) Security of supply, especially if the microgrids can be operated in an autonomous way.
- 3. Societal reasons:** (i) Local jobs (ii) Energy that belongs to the people.

A taxonomy for uber-like models for electricity



From the market point of view, the consumption of the 'single user' is equal to the sum of the consumption measured by the three meters, for every market period.

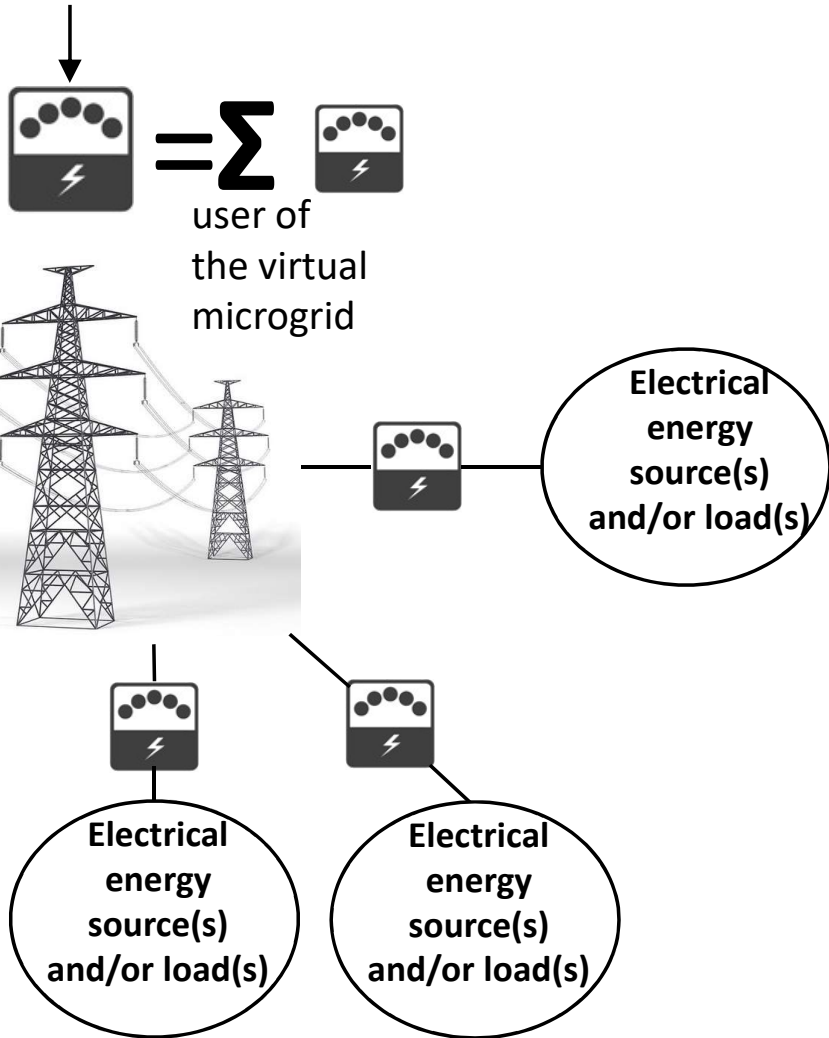


Model 3 and 4: The single-user virtual microgrid

1. If the user is located close to generation/storage (Model 3), it may have beneficial effects on the network to increase self-consumption in the virtual microgrid.
2. Model 3 tested in Belgium. Known as **E-Cloud**. Big storage generation/storage devices in an E-Cloud but they are divided up among several single users.
3. Standard regulations do not allow for the creation of virtual microgrids.

Model 5 and 6: The multi-user virtual microgrid

Consumption in the virtual microgrid,
as seen from the market



1. May be very helpful to integrate renewables if users are located close to each other (Model 5).
2. Difficult to have multi-user virtual microgrids that can operate in an autonomous way.
3. Easier to create a multi-user virtual microgrid in one area of a network than a multi-user microgrid. In a multi-user microgrid, one single potential user may block the creation of the microgrid.

Model 5 (not 6) authorized in France?

A piece of French regulation « authorizing » the creation of multi-user virtual microgrids for which all the users are connected to the same low-voltage feeder (Model 5):

Ordonnance n° 2016-1019 du 27 juillet 2016 relative à l'autoconsommation d'électricité

NOR: DEVR1615431R

ELI: <https://www.legifrance.gouv.fr/eli/ordonnance/2016/7/27/DEVR1615431R/jo/texte>

Alias: <https://www.legifrance.gouv.fr/eli/ordonnance/2016/7/27/2016-1019/jo/texte>

« Chapitre V

« L'autoconsommation

« Art. L. 315-1.-Une opération d'autoconsommation est le fait pour un producteur, dit autoproducteur, de consommer lui-même tout ou partie de l'électricité produite par son installation.

« Art. L. 315-2.-L'opération d'autoconsommation est collective lorsque la fourniture d'électricité est effectuée entre un ou plusieurs producteurs et un ou plusieurs consommateurs finals liés entre eux au sein d'une personne morale et dont les points de soutirage et d'injection sont situés sur une même antenne basse tension du réseau public de distribution.

« Art. L. 315-3.-La Commission de régulation de l'énergie établit des tarifs d'utilisation des réseaux publics de distribution d'électricité spécifiques pour les consommateurs participants à des opérations d'autoconsommation, lorsque la puissance installée de l'installation de production qui les alimente est inférieure à 100 kilowatts.

« Art. L. 315-4.-La personne morale mentionnée à l'article L. 315-2 organisatrice d'une opération d'autoconsommation collective indique au gestionnaire de réseau public de distribution compétent la répartition de la production autoconsommée entre les consommateurs finals concernés.

« Lorsqu'un consommateur participant à une opération d'autoconsommation collective fait appel à un fournisseur pour compléter son alimentation en électricité, le gestionnaire du réseau public de distribution d'électricité concerné établit les index de consommation de l'électricité relevant de ce fournisseur en prenant en compte la répartition mentionnée à l'alinéa précédent.

PS: Sorry for those of you who do not speak French

Model 7: EV – Car not always charged at home

A few comments on how this model could affect the electrical industry:

1. May help domestic microgrids with PV and batteries to go fully off grid. How? During a sunny period the owner of the (good-sized) domestic microgrid would charge its EV at home. Otherwise, he would charge it at another location. This would help the fully off-grid microgrid to **handle the inter-seasonal fluctuations** of PV energy.
2. The EVs could be charged immediately adjacent to renewable generation units where electricity costs may be much lower than retailing cost for electricity. Two numbers: retail price for electricity in Belgium: **250 €/MWh**. Cost of PV energy in Belgium: less than **100 €/MWh**.
May also help to avoid problems on distribution networks caused by renewables.

An App-based Algorithmic Approach for Harvesting Local and Renewable Energy Using Electric Vehicles

Antoine Dubois, Antoine Wehenkel, Raphael Fonteneau, Frédéric Olivier and Damien Ernst
Department of Electrical Engineering and Computer Science, University of Liège, Allée de la Découverte, 10, 4000 Liège, Belgium
{*Antoine.Wehenkel, Antoine.Dubois*}@student.ulg.ac.be , {*Raphael.Fonteneau, Frederic.Olivier, Dernst*}@ulg.ac.be

Keywords: Multi-agent System, Electric Vehicles, Renewable Energy

Abstract: The emergence of electric vehicles (EVs), combined with the rise of renewable energy production capacities, will strongly impact the way electricity is produced, distributed and consumed in the very near future. This position paper focuses on the problem of optimizing charging strategies for a fleet of EVs in the context where a significant amount of electricity is generated by (distributed) renewable energy. It exposes how a mobile application may offer an efficient solution for addressing this problem. This app can play two main roles. Firstly, it would incite and help people to play a more active role in the energy sector by allowing photovoltaic (PV) panel owners to sell their electrical production directly to consumers, here the EVs' agents. Secondly, it would help distribution system operators (DSOs) or transmission system operators (TSOs) to modulate more efficiently the load by allowing them to influence EV charging behaviour in real time. Finally, the present paper advocates for the introduction of a two-sided market-type model between EV drivers and electricity producers.

Download the reference: [An App-based Algorithmic Approach for Harvesting Local and Renewable Energy Using Electric Vehicles.](#)

Model 8: V2G – Vehicle discharging only at home

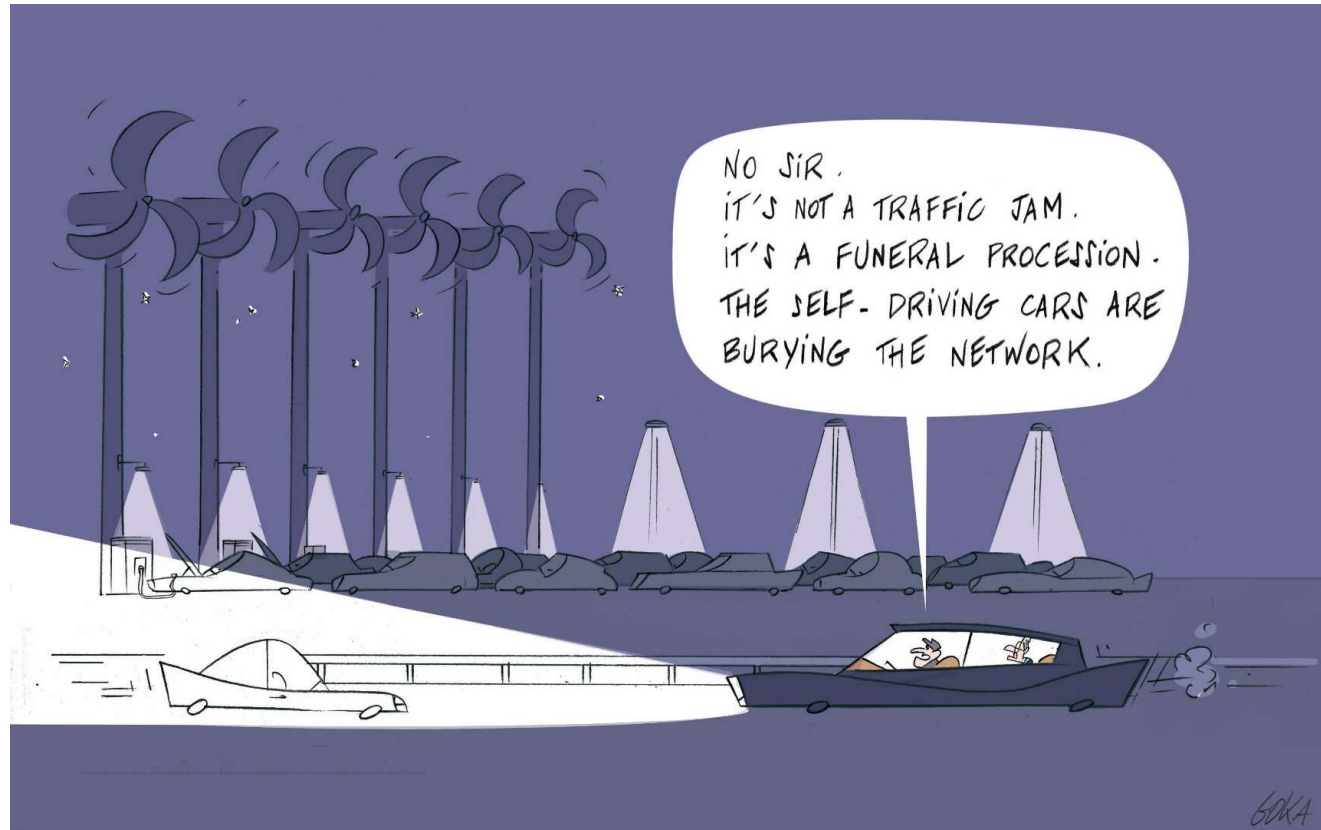
1. Could allow for the creation of fully off-grid microgrids that do not have their own generation capacities.

2. **Self-driving EVs** could, during the night, autonomously bring back electricity to the house. This electricity could be stored in the batteries of the house.



Model 9: V2G – Car as a substitute for the utility grid

EV charging could be carried out next to electricity sources at a cheap price. Afterwards, EVs could directly sell their electricity (without using the grid) to any electricity consumer at a higher price. As such, they will act as a **true competitor for the utility grid**.



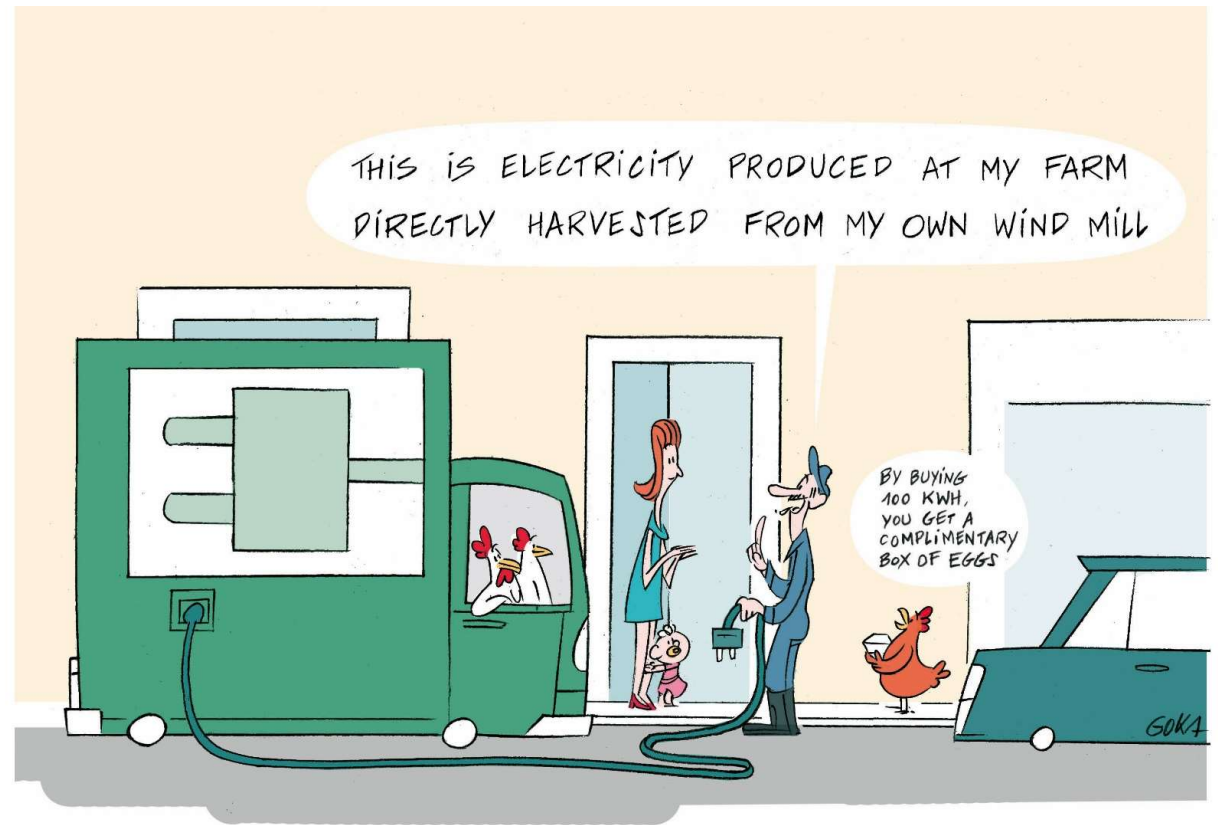
Model 9 may become very successful with the rise of **self-driving cars** for two main reasons:

1. No one will be needed to drive the car to collect electricity and deliver it to the electricity consumer.
2. Fleets of self-driving cars will not be used during the night to transport passengers. Using them during the night as a substitute for the electrical network will therefore accrue **very little additional capital costs**.



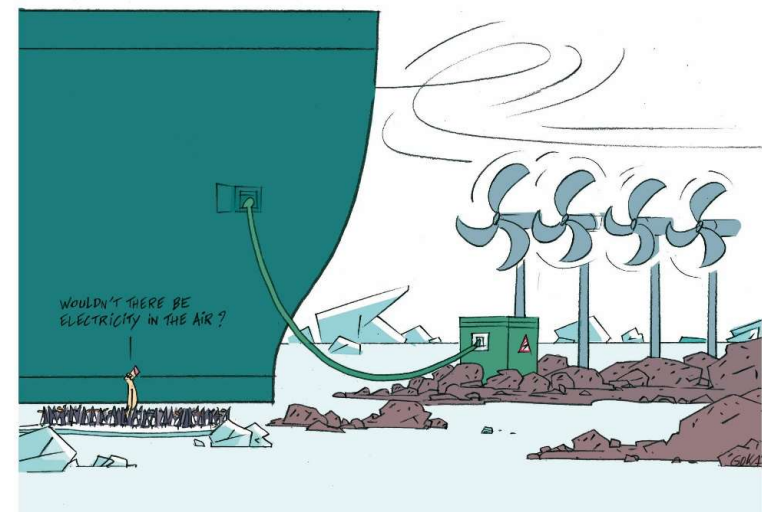
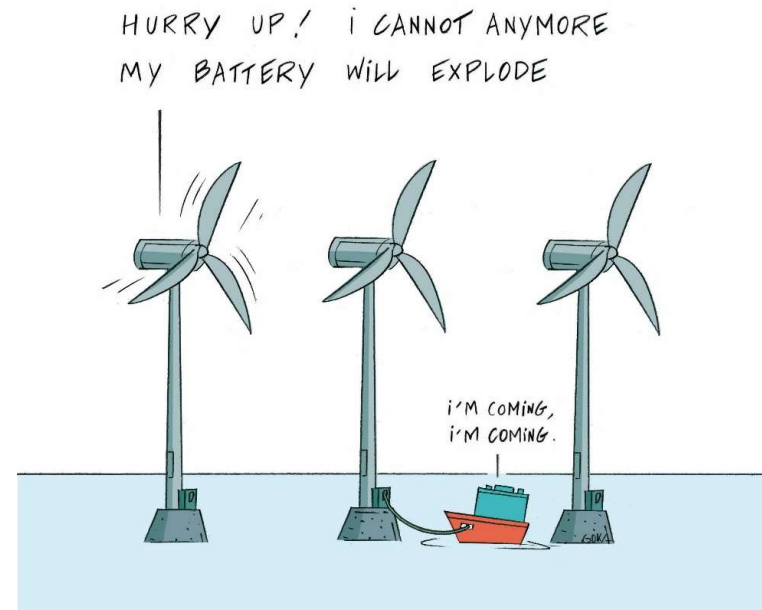
Model 10: No EV battery. Delivery of electricity using storage devices

1. Many producers of electrical energy could start delivering electricity directly to home batteries through the use of mobile batteries.
2. Delivery system may be significantly cheaper than the cost of running distribution networks in rural areas.
3. Biggest competitor of Model 10: Model 9.



Model 11: No EV battery. Storage devices as a substitute for the transmission grid

1. The off-shore grid could be replaced by a system of boats with batteries.
2. Renewable energy collected at remote locations, such as the East coast of Greenland for example, where there is ample wind, could be brought back to consumption centres with using large ships full of batteries. Model is competitive with undersea cables once cost of batteries drops **below 50 €/kWh**.
3. Model 11 could be combined with a model based on electricity distribution with batteries.



If I just had one tweet for commenting on each of these models.

Model 1: Microgrid – single user.



Damien ERNST

@DamienERNST1

First uber-like model for the electrical sector.
Deserves respect ❤️ ❤️ Make sure to come up
with the right network tariff for microgrids.

Model 2: Microgrid – multi-user.



Damien ERNST
@DamienERNST1

Crazy that Model 2 is not allowed by current regulation. HUGE REGULATORY MISTAKE that slows down the green revolution.
[#FireTheRegulator](#)

Model 3: The single-user virtual microgrid. Power generation and/or storage close to the user



Damien ERNST
@DamienERNST1

Great. I will be able to have my own microgrid.
I live in an apartment building.

Model 4: The single-user virtual microgrid . Generation and/or storage anywhere



Damien ERNST

@DamienERNST1

Don't like this model. I hardly see the benefits it could bring to the grid. I'd rather buy shares in a generation company 😜

Model 5: The multi-user virtual microgrid. Generation and/or storage close to the user



Damien ERNST

@DamienERNST1

Model easy to put in place. With the right regulation and technical knowhow, it can help to integrate renewable energy into the grid.

Model 6: The multi-user virtual microgrid. Generation and/or storage anywhere for the user



Damien ERNST

@DamienERNST1

It looks to me like a new type of retailer.
Should we really invent a new type of model
that does not bring much novelty? [#NoSense](#)



Model 7: EV – Car not always charged at home



Damien ERNST

@DamienERNST1

Use this opportunity to get more money for your green energy and solve problems caused to the distribution grid by PVs [#BuyMyAppldea](#)

🌐 À l'origine en anglais

An App-based Algorithmic Approach for Harvesting Local and Renewable Energy Using Electric Vehicles

Antoine Dubois, Antoine Wehenkel, Raphael Fonteneau, Frédéric Olivier and Damien Ernst
Department of Electrical Engineering and Computer Science, University of Liège, Allée de la Découverte, 10, 4000 Liège, Belgium
{*Antoine.Wehenkel, Antoine.Dubois*}@student.ulg.ac.be , {*Raphael.Fonteneau, Frederic.Olivier, Dernst*}@ulg.ac.be

Model 8: V2G – Car discharging only at home



Damien ERNST

@DamienERNST1

Pretty sure that V2G will trigger the development of fully off-grid microgrids with PV and local storage. [#RegulatoryNightmare](#)

Model 9: V2G – Car as a substitute for the utility grid



Damien ERNST

@DamienERNST1

Geeks will love to have self-driving cars replacing the network. It looks like science-fiction but it is not ;) [#SelfDrivingCarRevolution](#)

Model 10: No EV battery. Delivery of electricity with storage devices



Damien ERNST

@DamienERNST1

Make it sexy: Use drones rather than trucks to deliver electricity. [#DroneGeneration](#)

🌐 À l'origine en anglais



Model 11: No EV battery. Storage devices as a substitute for the transmission grid



Damien ERNST @DamienERNST1 · 3 s

TSOs (except State Grid Corporation of China) too slow to build a global grid.
Good to have another solution in sight. #GlobalGrid

🌐 À l'origine en anglais

Renewable Energy 57 (2013) 372–383

Contents lists available at SciVerse ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene

The Global Grid

Spyros Chatzivasileiadis^{a,*}, Damien Ernst^{b,2}, Göran Andersson^{a,1}

^aPower Systems Laboratory, ETH Zurich, 8092 Zurich, Switzerland
^bInstitut Montefiore, University of Liège, 4000 Liège, Belgium

ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received 21 June 2012 Accepted 10 January 2013 Available online</p> <p><i>Keywords:</i> Global electricity grid Electricity transmission network Global electrical network Renewable energy Wind power Solar power</p>	<p>This paper puts forward the vision that a natural future stage of the electricity network could be a grid spanning the whole planet and connecting most of the large power plants in the world; this is the "Global Grid". The main driving force behind the Global Grid will be the harvesting of remote renewable sources, and its key infrastructure element will be the high capacity long transmission lines. Wind farms and solar power plants will supply load centers with green power over long distances.</p> <p>This paper focuses on the introduction of the concept, showing that a globally interconnected network can be technologically feasible and economically competitive. We further highlight the multiple opportunities emerging from a global electricity network such as smoothing the renewable energy supply and electricity demand, reducing the need for bulk storage, and reducing the volatility of the energy prices. We also discuss possible investment mechanisms and operating schemes. Among others, we envision in such a system a global power market and the establishment of two new coordinating bodies, the "Global Regulator" and the "Global System Operator".</p>

© 2013 Elsevier Ltd. All rights reserved.