The Customer - the forgotten one ›

– or the Impact of full Decarbonisation on Utilities, their Customers and the CoNDyNet Project

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Focus-Workshop CoNDyNet
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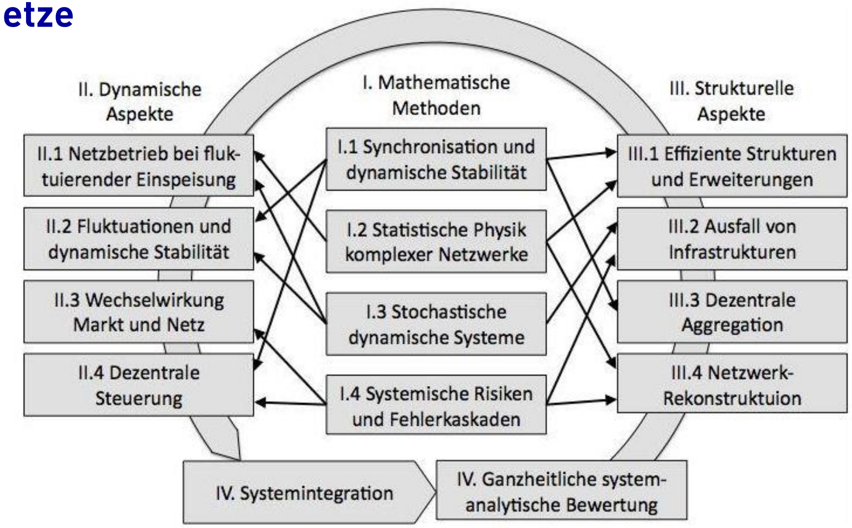
Prologue

- **More and more citizens/companies want to do something for climate protection themselves and are already doing something about it...**

  ...and they no longer wait for political decisions!

The CoNDyNet project

Verbundprojekt CoNDyNet -
Kollektive Nichtlineare Dynamik Komplexer Stromnetze



Great questions, but do they also sufficiently take into account the actual developments?

Source: http://www.condynet.de/projekt.html

part 1: the meta-level

Full decarbonisation means...

..nothing else than:

0 CO_2 in 2050

or actually a CO_2 reduction from 2040!!

The starting and finishing point: The Paris Climate Change Conference November 2015

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From the energy transition **... to the de-carbonisation of all sectors**

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

COP24 | KATOWICE

CO_2

More or less complete de-carbonisation

- Electricity
- Heating
- Transportation
- Products (internal CO_2 footprint)
- Food
- ...

Primary energy balance of Germany

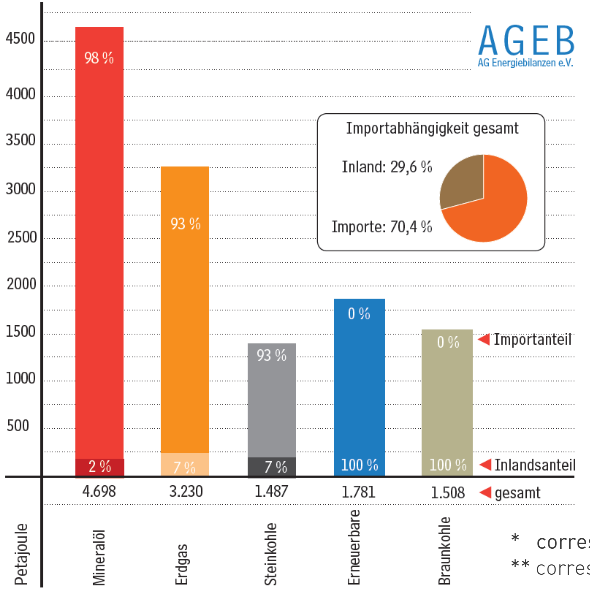
The German energy balance

- Over 70 percent covered by imports
- About 98% import dependency on mineral oil
- About 93% import dependency on gas and hard coal

Is the German energy balance sustainable, resilient or CO_2-free?

Import dependence of the German energy supply in 2017

(Total 13,594 PJ* - Domestic production 4,024 PJ**)



* corresponds to 3,780 TWh
** corresponds to 1,120 TWh

First thesis

› **No, the German energy balance is neither sustainable, resilient nor CO_2-free!**

part 2: the generation side

Local RE-generation vs. energy imports

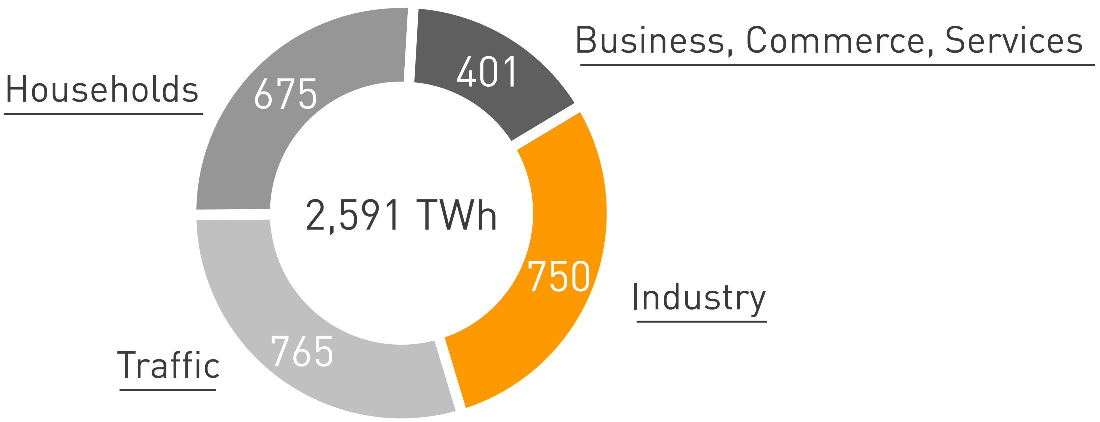
What possibilities do we have regarding our energy import dependency?

- Option 1: 100% national or European based renewable energy sources
- Option 2: Still more than 70% import dependency on (renewable) energy sources – in the case of Germany
- Option 3: Something in between

But do we even have the theoretical potential of a complete energy independency and how much energy do we need?

Initial Position:
The final energy consumption in Germany

Final energy consumption 2017 [TWh/a]



Primary energy demand 3,780 TWh/a

Electricity "just" 530 TWh/a

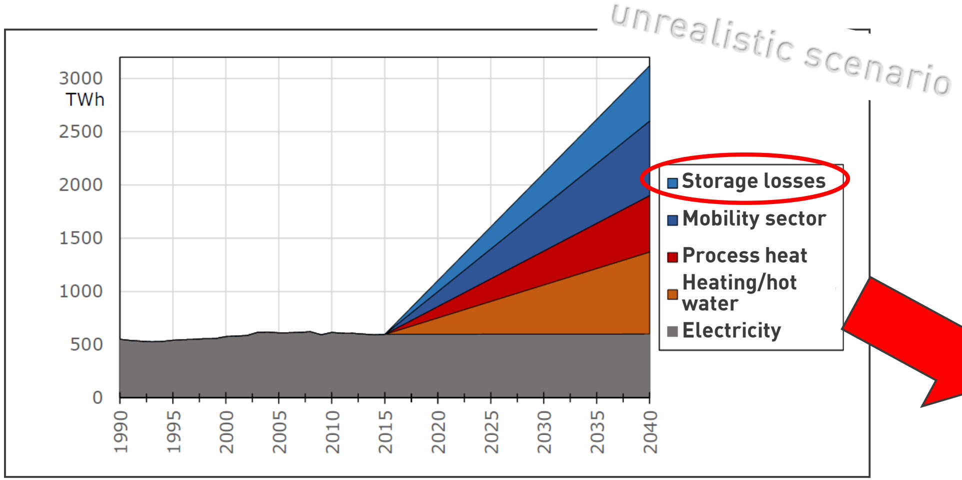
› **Has to be CO_2-free! But how?**

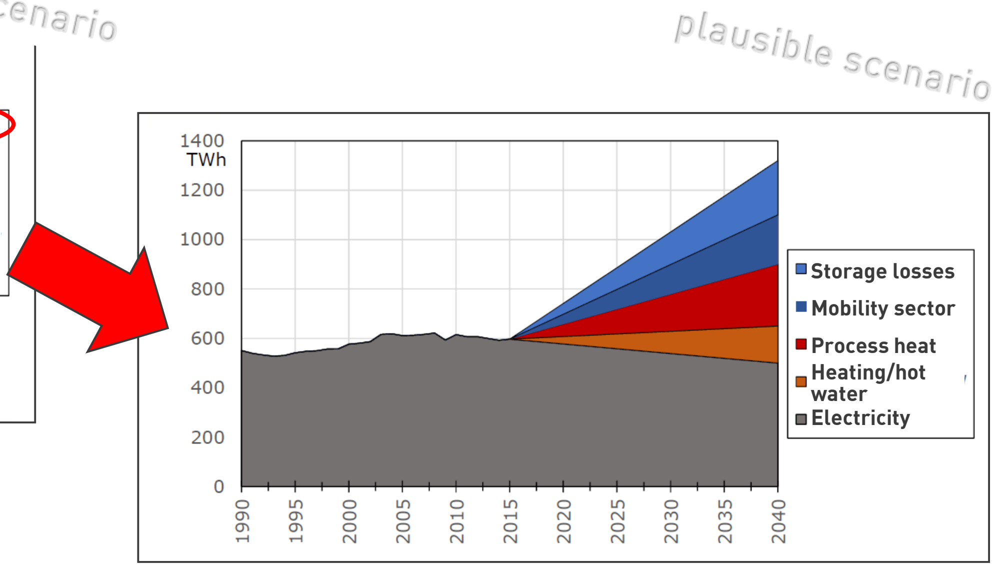
Source: AG Energiebilanzen, own representation

Sector coupling significantly increases demand for electricity

100 %-proportion of electricity in Germany means:

- Without efficiency measures up to 3,000 TWh/a
- With efficiency measures up to 1,300 TWh/a

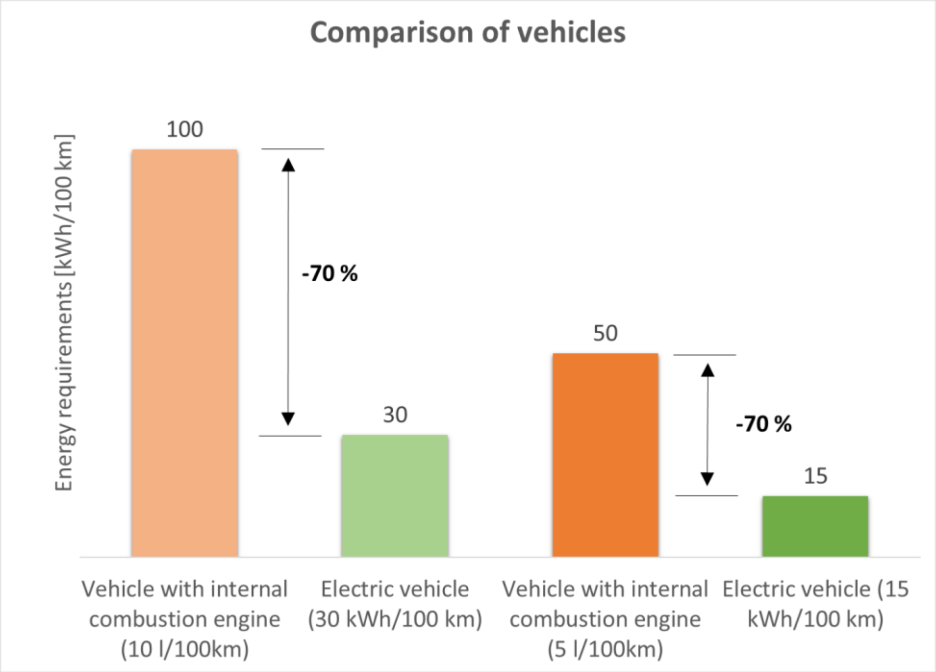




Source: Quaschning, Volker; Sektorkopplung durch die Energiewende; htw Hochschule für Technik und Wirtschaft Berlin, 20. Juni 2016

Disruptive efficiency gains

Example: vehicles – increase in efficiency 70 %

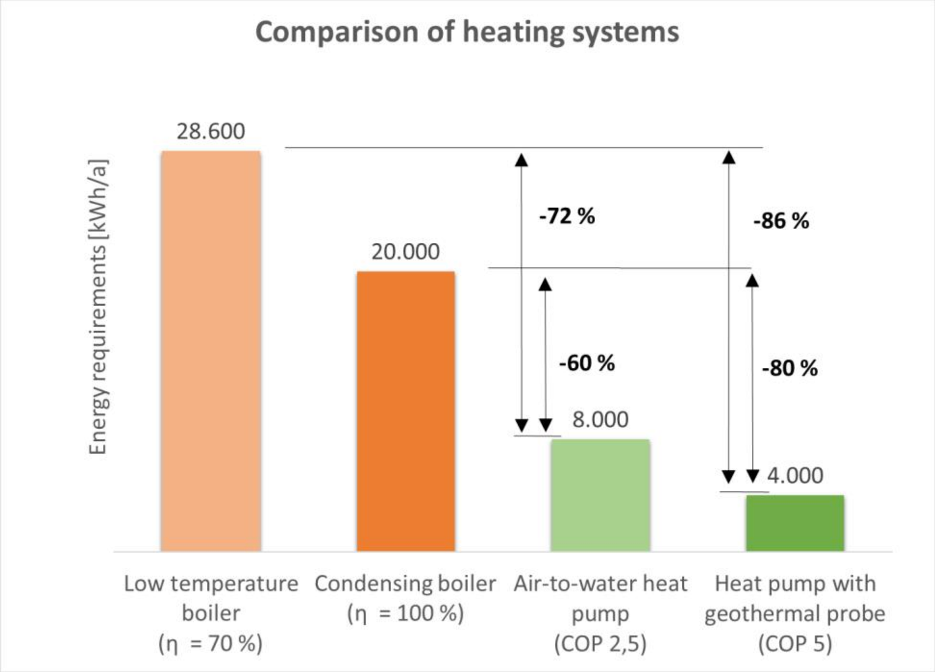


Key figures vehicles:

- Vehicle with internal combustion engine
  - Large car: 10 l per 100 km → ~100 kWh
  - Small car: 5 l per 100 km → ~ 50 kWh
- Electric vehicle
  - Large car: ~30 kWh per 100 km
  - Small car: ~ 15 kWh per 100 km

Disruptive efficiency gains

Example: heating systems – increase in efficiency 60 – 86 %



Key figures vehicles:

- Energy requirement for heating and hot water of 20,000 kWh/a
- Gas: 1 m³ corresponds to ~10 kWh
- Fuel oil: 1 l corresponds to ~10 kWh

Need for additional RE-capacity due to the sector coupling

Development of renewable electricity generation and electricity consumption to achieve climate-neutral energy supply, taking efficiency measures into account

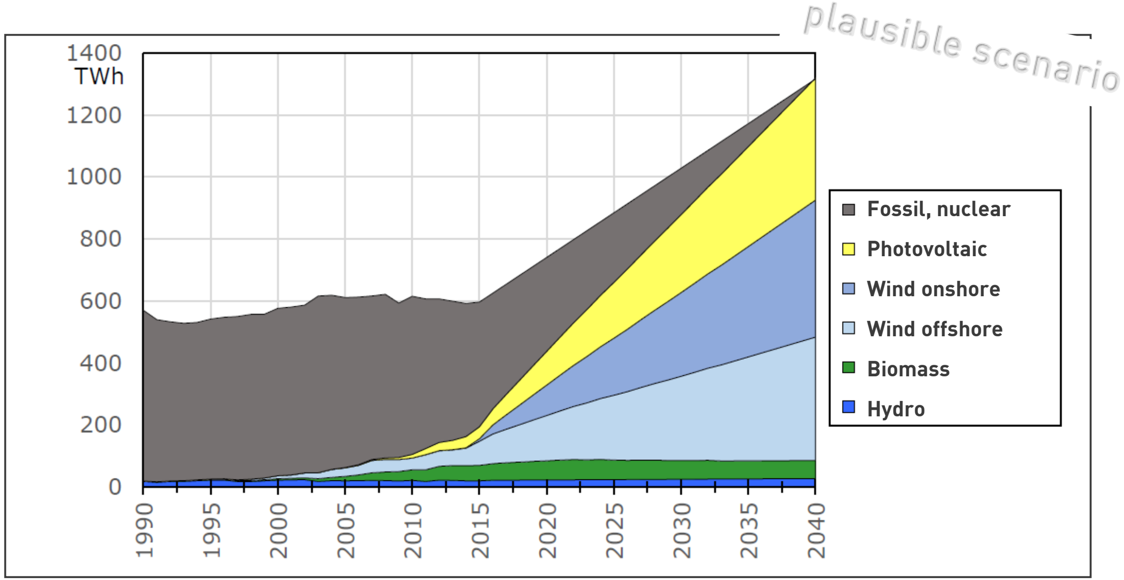
This means:

- about 50 % of efficiency measures

This means:

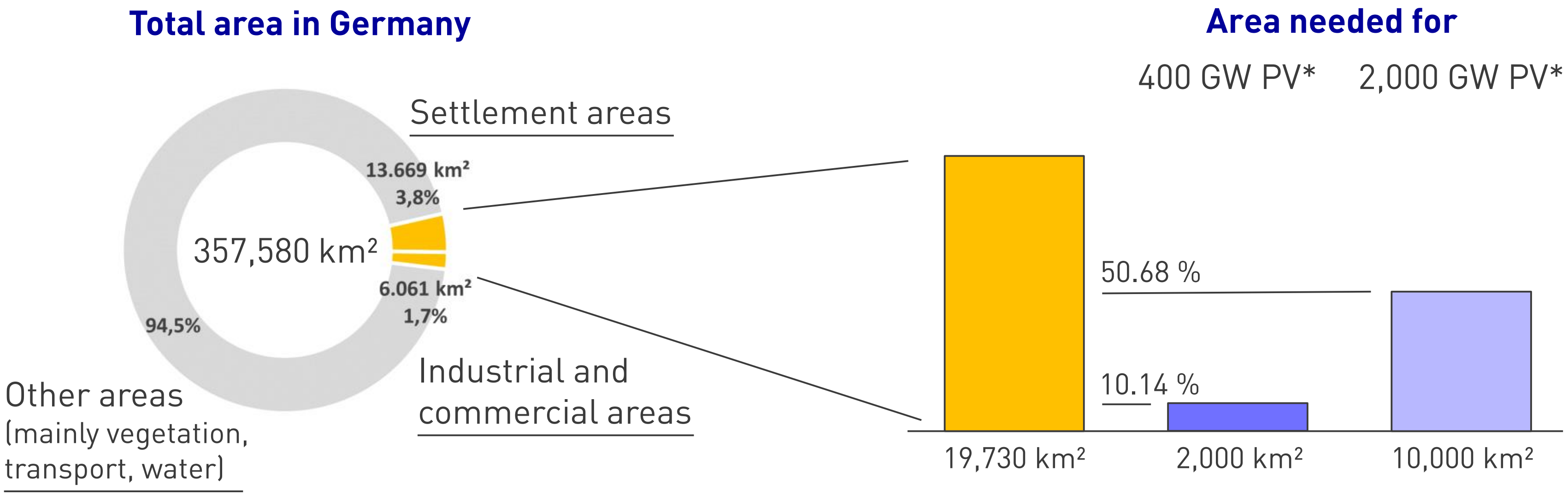
- about 400 GW of PV
- about 200 GW of onshore wind
- about 75 GW of offshore wind
- *(about 20 GW of biomass)*
- *(about   7 GW of hydro)*

!



Source: Quaschning, Volker; Sektorkopplung durch die Energiewende; htw Hochschule für Technik und Wirtschaft Berlin, 20. Juni 2016

PV potential in Germany



* 5 m^2/kW_{peak}

› **More than enough space for PV systems on built-up areas!**

Source: Statistisches Bundesamt (status 2016); own calculations

Second thesis

- **Theoretically, full energy import independence is possible, and...**

  ...there is a substantial need for additional RE-capacity due to the sector coupling!

By the way, for utilities this means...

What a great opportunity!!

- More RE-capacity and mot backup capacity
- More operation and maintenance
- More digital processes
- ...and maybe more grids

→ But in any case, just more work!

part 3: the customer side

But what do the customers do?

The customer side – the big unknown...

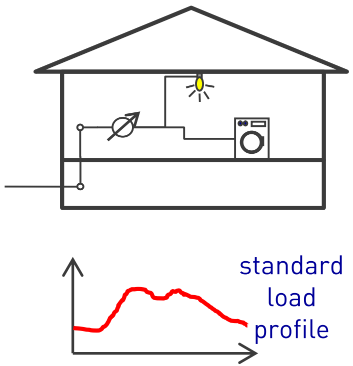
... and the forgotten one!!

Image source: http://www.marketing-blog.biz

The customer role: initial position and step one

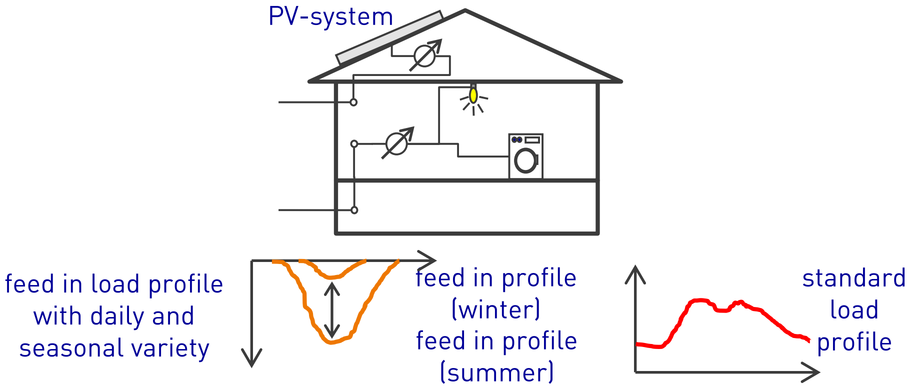
Initial behaviour:

- Customer without PV-system or battery
- 100 % electricity from grid
- 24/7 grid connection required



Step one behaviour:

- Customer with PV-system
- 100 % electricity from grid
- 100 % feed in due to feed in law
- feed in tariff > tariff for electricity
- 24/7 grid connection required



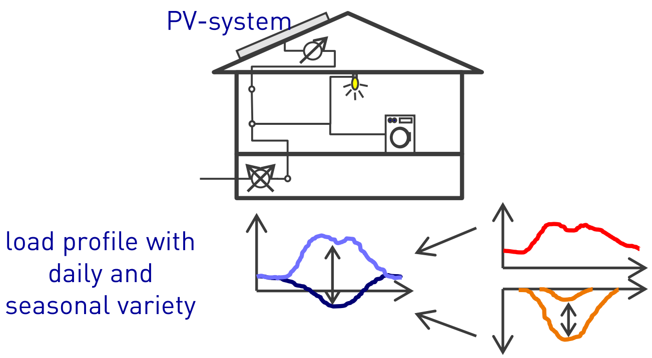
The customer role: step two and three

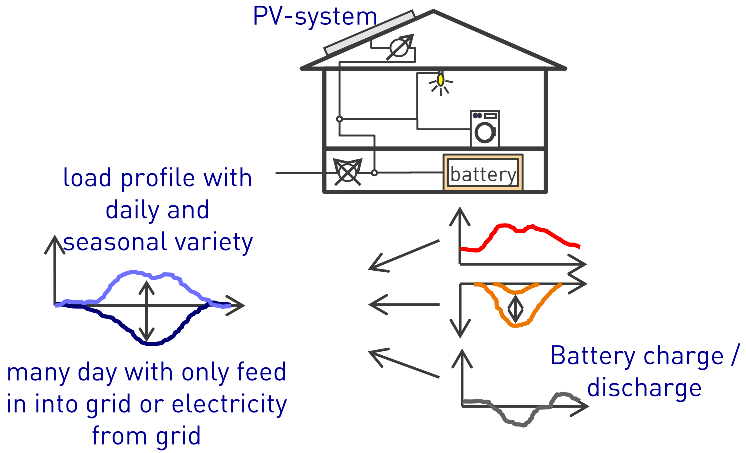
Adapted step two behaviour:

- Customer with PV-system and self-consumption
- 24/7 grid connection required
- 20 – 40 % self-consumption rate
- feed in tariff < tariff for electricity

Adapted step three behaviour:

- PV-system, self-consumption and battery
- ~70 % self-consumption rate
- feed in tariff < tariff for electricity
- 24/7 grid connection not necessarily required (depending on battery system)



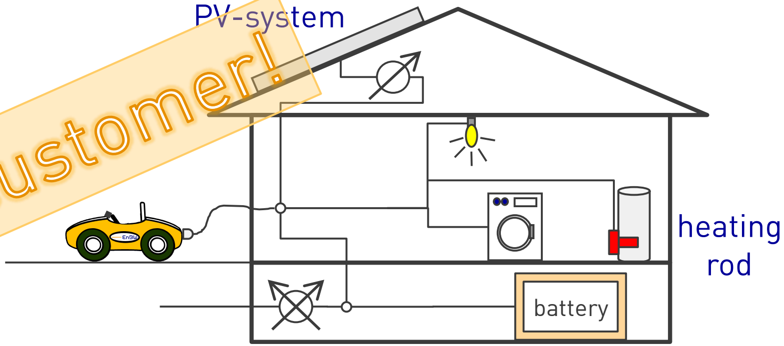


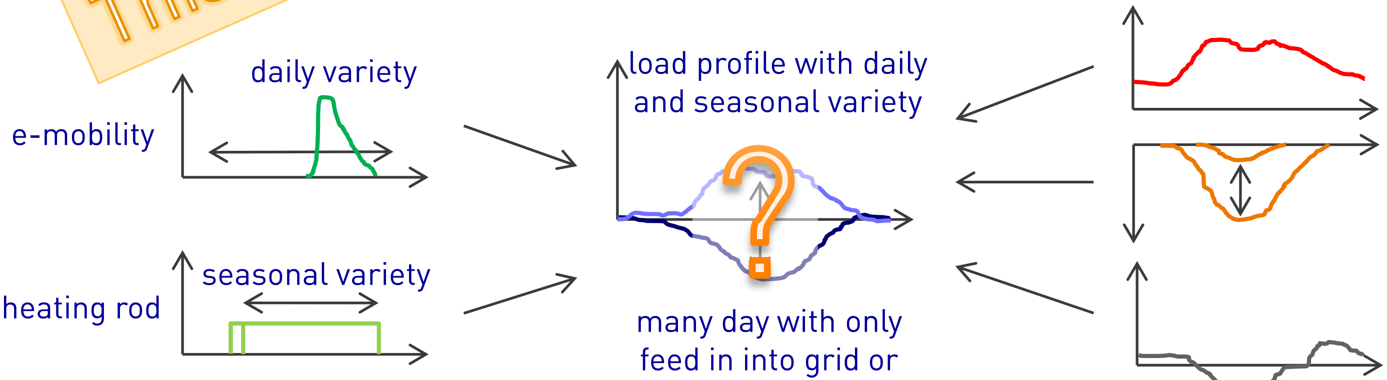
The customer role: step four

Adapted behaviour:

- Customer with PV-system, self-consumption, battery, e-heating and e-mobility
- ~40 % electricity from grid
- ~60 % self-consumption
- 24/7 grid connection not necessarily required (depending on battery system)

This is the new customer!





Third thesis

- **Customers will be generating, store and consuming more and more energy themselves...**

  ...and the behaviour at the grid connection point will change completely (forget the standard load profiles or any other profiles)!

part 4: the customer side, next level

And what are the customers doing locally?

The customer – the big unknown...

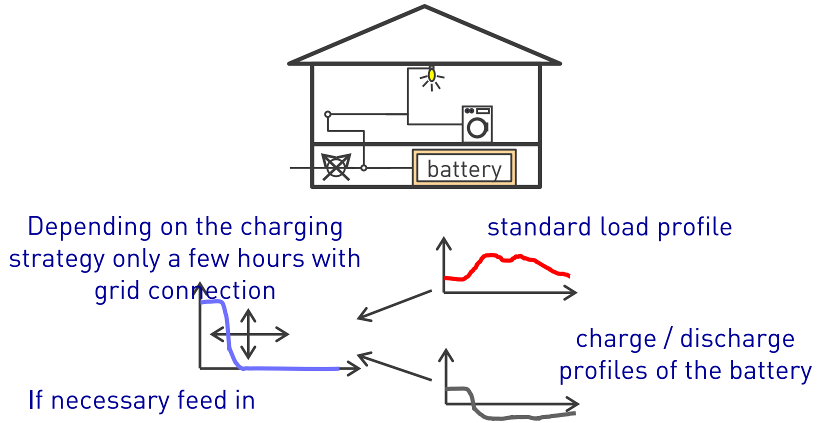
...and what happens at the local level (behind the meter)?

Image source: http://www.marketing-blog.biz

The “new” customers – a visionary outlook (1/2)

Customer 1 with battery storage

- Average energy demand of 10 kWh/a (3,650 kWh/a)
- Stand-alone battery storage with 40 kWh storage capacity and at least 20 kW power
- 10 % rolling losses (365 kWh/a)
- (heating via district heating or passive energy house)



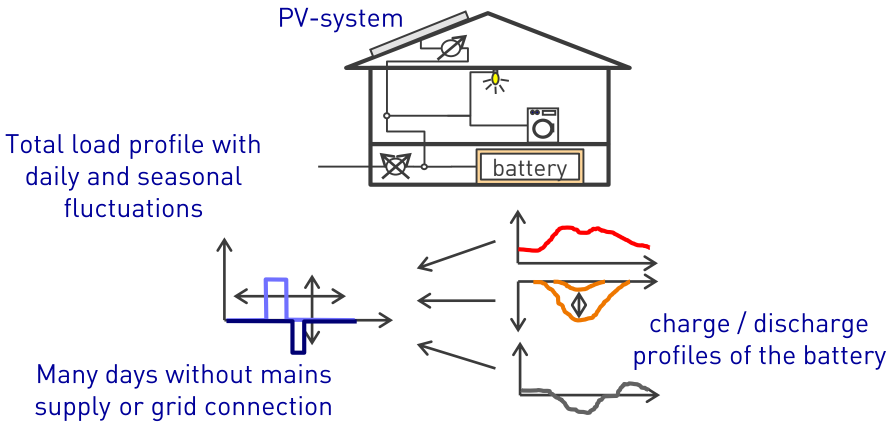
This means

- Customer flexibility potential of up to 72 h
- Only every 3 days a grid connection of 2 h with a power of about 20 kW necessary
- Customer requires a maximum of 245 h/a of grid connection - that corresponds to just 2.8 % of the hours of a year

The "new" customers – a visionary outlook (2/2) – In extreme case, this means at the grid transfer point

Customer 2 with battery storage and PV-system

- Average energy demand of 10 kWh/a (3,650 kWh/a)
- Stand-alone battery storage with 40 kWh storage capacity and at least 20 kW power
- 10 kW_{peak} PV-system with 10,000 kWh/a generation and a maximum daily generation of 65 kWh



This means

- Only a maximum daily power supply of about 2.5 h with about 20 kW is necessary for power purchase and feed in
  - when generating >40 kWh/d, a (partial) grid feed-in at PV production times is necessary
- Customer requires a maximum of 500 h/a of grid connection - that corresponds to just 5.7 % of the hours of a year, assuming that there are less than 180 sunny days per year

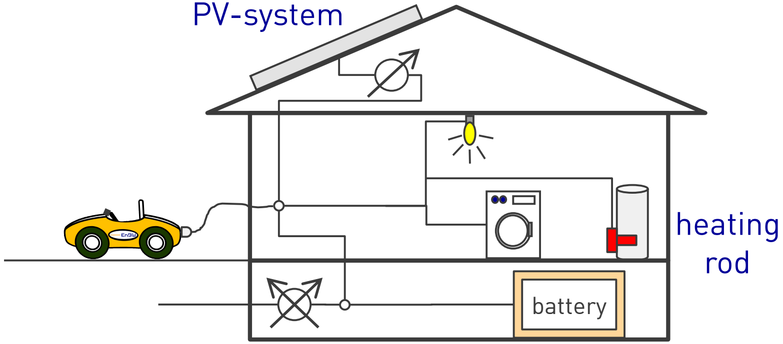
And then add heat pumps and electric vehicles!

The customers role: The local shift load potentials

"just" an intermediate step

Three examples of local flexibility and load management potentials:

- (Small scale) stationary battery systems
  - Assumption: 50 % of the residential buildings (10 m) with battery system (aver. capacity of 10 kW)
  - **Additional capacity of 100 GW**
- (Small scale) moveable battery storage (e-mobility)
  - Assumption: 50 % as e-vehicles (25 m) with aver. charge capacity of 20 kW
  - **Additional capacity of 500 GW**
- Heat storage (hybrid heating)
  - Heating rod with a backup heating system based on gas, oil, heat pumps, etc.
  - Assumption: 50 % of the residential buildings (10 m) with a heating rod (average capacity of 10 kW)
  - **Additional capacity of 100 GW**



Forth thesis

- **If the customer have a grid connection capacity of 35 kW, they will also use it in the future...**

  ...and no longer the "planned" average capacity of the grid operators of about 2 kW!

But what does that mean for utilities?

Answers from utilities

Business opportunities

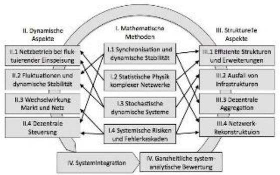
- More customer focused solutions (→ more decentralised solutions) — Business opportunities
- More local renewable energies and storage solutions (→ less grid dependency)
- More energy efficiency (→ less demand) — Business opportunities
- More island network capabilities (→ less grid dependency) — Business opportunities
- More decentralised IT-infrastructures (→ more decentralised solutions)
- Better software and more hackers protection (→ less attack surfaces)

Business opportunities and challenges for the employees

But that also means that the utilities have to reinvent themselves

Impact on the CoNDyNet2-project?

The customer – the big unknown?



Maybe, but in any case with a disruptively changed network usage behaviour – don't forget them!

Image source: http://www.marketing-blog.biz

- **Customer behaviour – and not only that of household customers – will change fundamentally...**

  ...with corresponding serious effects on grid usage behaviour!

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