IndustRE webinar:
Flexibility potential of industrial plants

"Demand side flexibility business case estimation made easy …"

September 6, 2016

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IndustRE
Using the
flexibility potential
in energy intensive industries to
facilitate further grid integration of
variable renewable
energy sources

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WIP

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vito Energy Ville

Imperial College London

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IndustRE

Using the
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Chemicals | Non-ferrous metals | Steel | Cold storage | Water treatment

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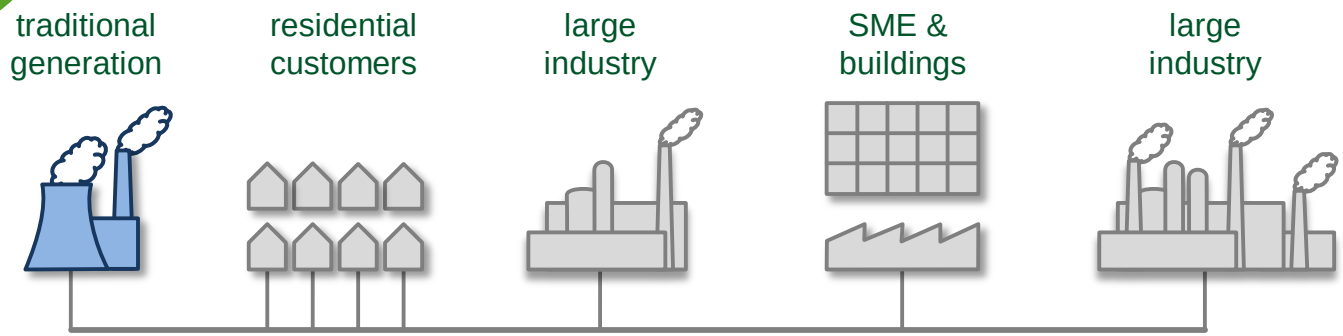
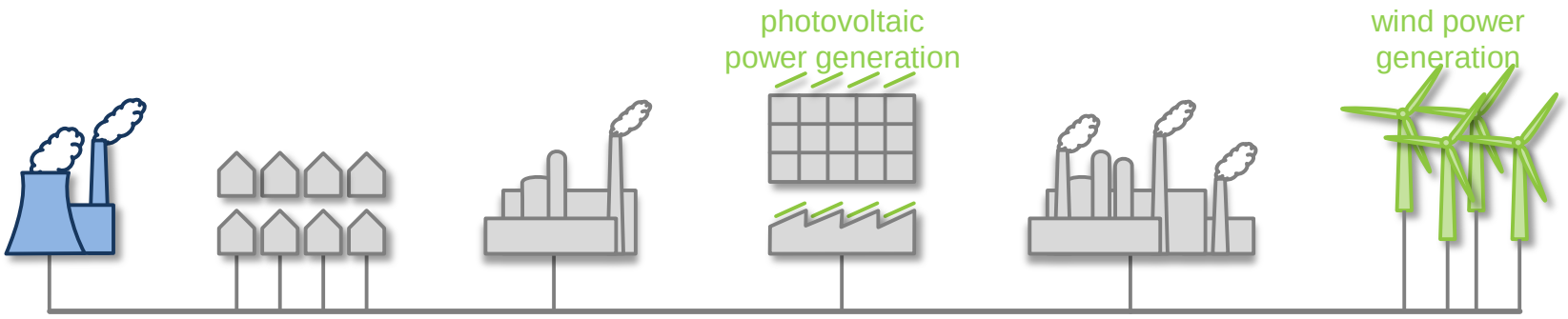
The challenge of tomorrow's electricity grid



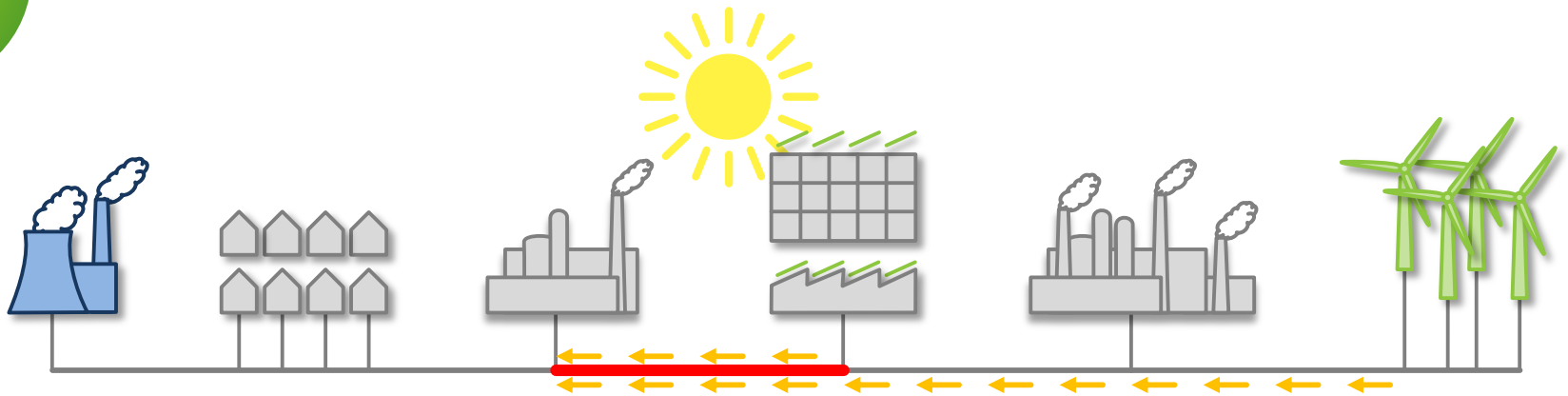
"An electricity grid with traditional generation, residential, medium sized and large industrial customers"

The challenge of tomorrow's electricity grid



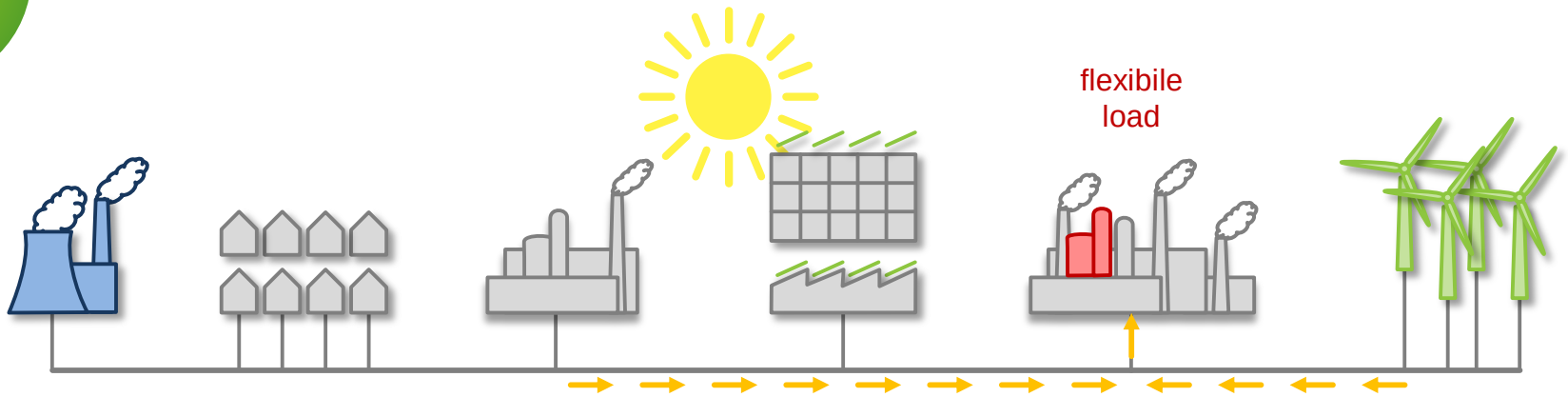
"Today, introduction and growth of renewable energy change the electricity system significantly"

The challenge of tomorrow's electricity grid



"For example when large amounts of renewable energy are injected, grid overload situations are possible."

The challenge of tomorrow's electricity grid



"Activation of additional demand can help to solve this.
*This is **Demand Response** or **Demand Side Management**"*

Quote (Art. 15.8) from the European Commission Energy Efficiency Directive (2012/27/EU):

"Member states shall promote access to and participation of Demand Response in balancing, reserves and other system services markets"

Contents

How can you make money with flexibility?

business models

regulation

market data

flexibility model

Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity						
	Network charges						
Day-ahead optimization	Commodity						
	Network charges						
Reserve capacity	FC reserve						
	FR reserve						
	R reserve						
Imbalance optimization							
On-site VRE optimization							

What is possible from a legal point of view?

business models

regulation

market data

flexibility model

"Although EU guidelines are quite clear, implementation pace is different…"

Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Day-ahead optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Reserve capacity	FC reserve	●	●	●	●	●	●
	FR reserve	●	●	●	●	●	●
	R reserve	●	●	●	●	●	●
Imbalance optimization		●	●	●	●	●	●
On-site VRE optimization		●	●	●	●	●	●

- ● business case is viable in exisiting regulatory framework
- ● business case limited viability/restricted in current regulatory framework
- ● business case impossible in existing regulatory framework

Which price data is available?

business models

regulation

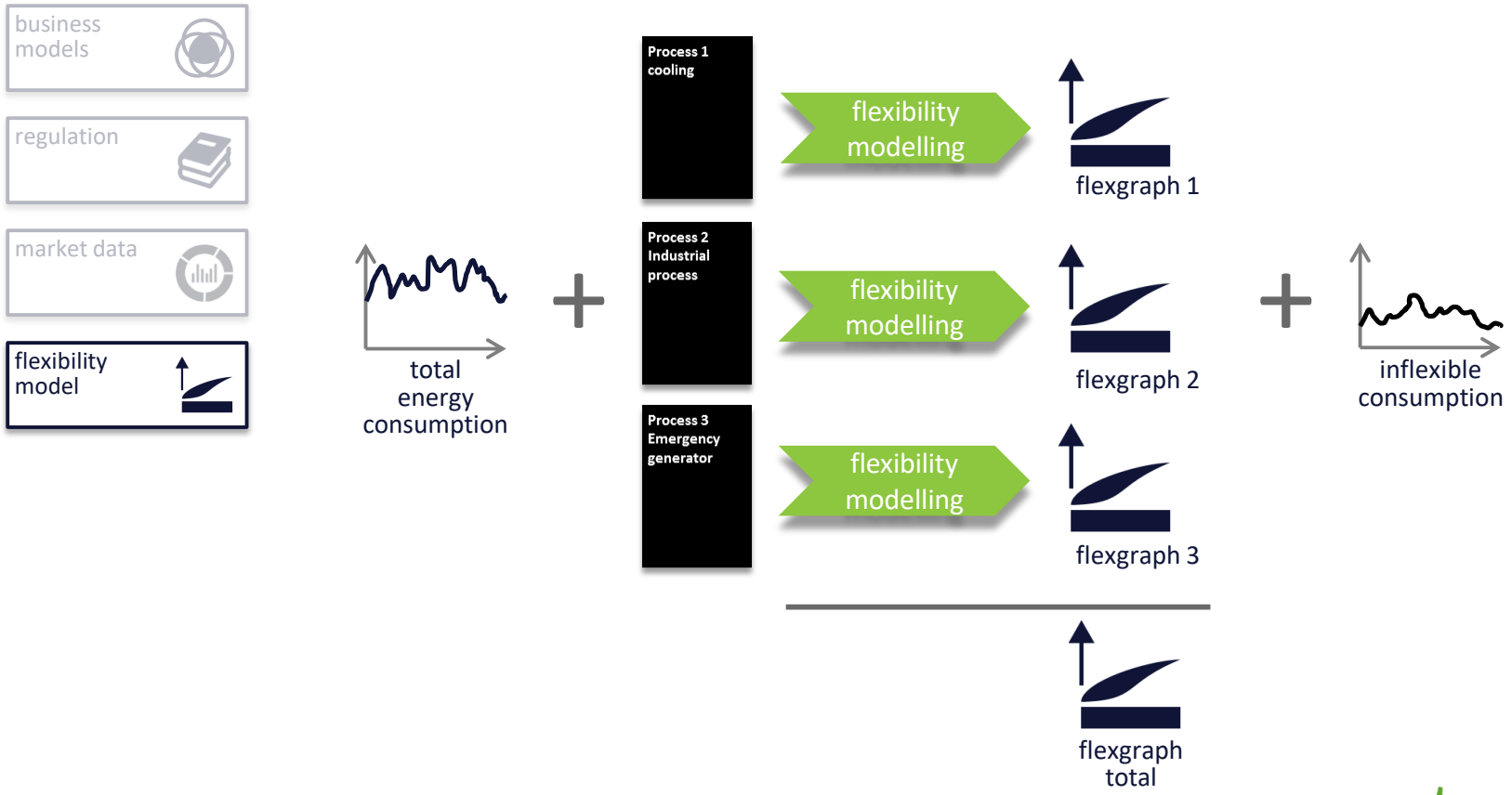
market data

flexibility model

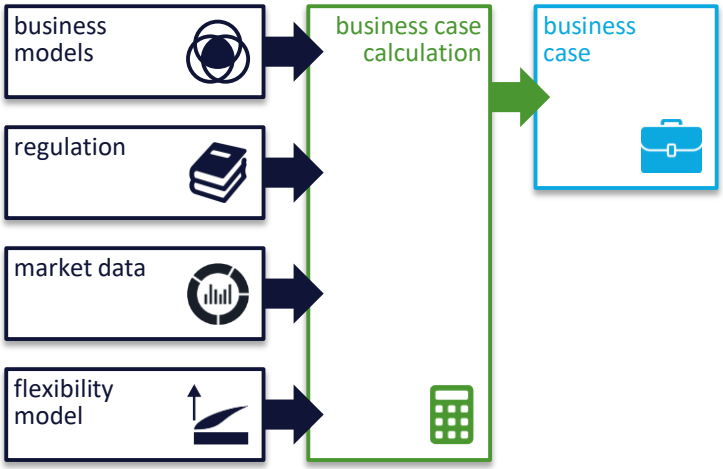
Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Day-ahead optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Reserve capacity	FC reserve	●	●	●	●	●	●
	FR reserve	●	●	●	●	●	●
	R reserve	●	●	●	●	●	●
Imbalance optimization		●	●	●	●	●	●
On-site VRE optimization		●	●	●	●	●	●

public price data available
bilateral price data estimates available
(bilateral) price data not available

How much flexibility is available?



Calculate the business case



Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	PP	PP	PP	PP	PP	PP
	Network charges	PP	PP	PP	PP	PP	PP
Day-ahead optimization	Commodity	PP	PP	PP	PP	PP	PP
	Network charges	PP	PP	PP	PP	PP	PP
Reserve capacity	FC reserve	C	C	C	-	-	C
	FR reserve	-	C/PP	C/PP	-	-	C
	R reserve	C	C	C/PP	-	-	C
Imbalance optimization		DIP	DIP	PP	DIP/PP	DIP	DIP
On-site VRE optimization		DS	DS	DS	DS	-	DS

PP Price profile optimization method (energy + peak)
DS Dual supplier optimization method (supplier + own production + peak)
DIP Dual imbalance price optimization
C Total costs optimization method (capacity only)

Contents

Skills for creating a flexibility model …

A flexibility model is the result of a 2 stage process:

selection stage:

- identification of flexibility during a site survey or audit
- requires good top-level understanding of industrial processes with focus on energy flows

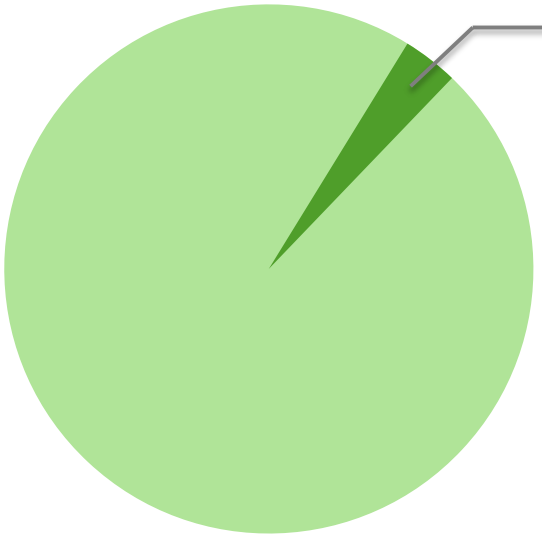
modelling stage:

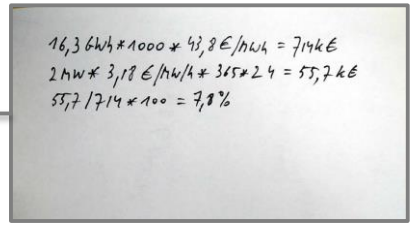
- construction of a mathematical model which describes production process and constraints from energy consumption point of view
- requires understanding of modelling and optimization techniques

➔The combination of skills is not so obvious

Business case calculation complexity …

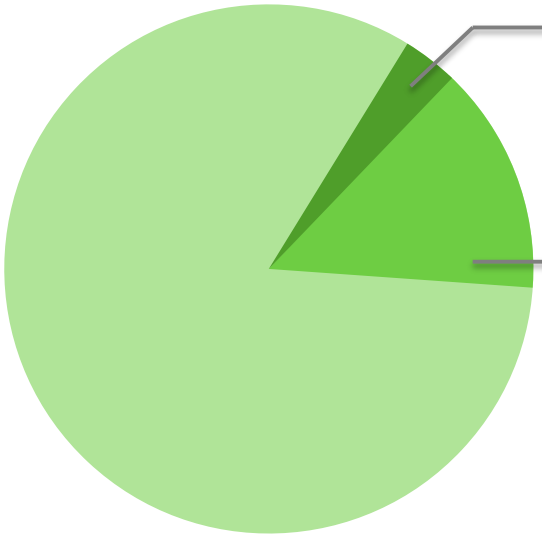
business case calculation

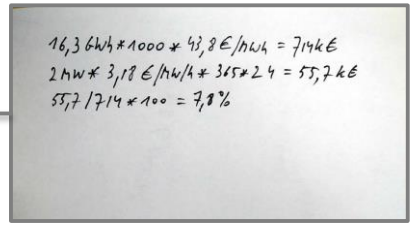


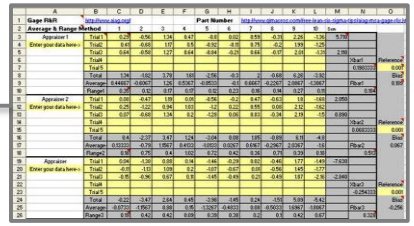


Business case calculation complexity …

business case calculation

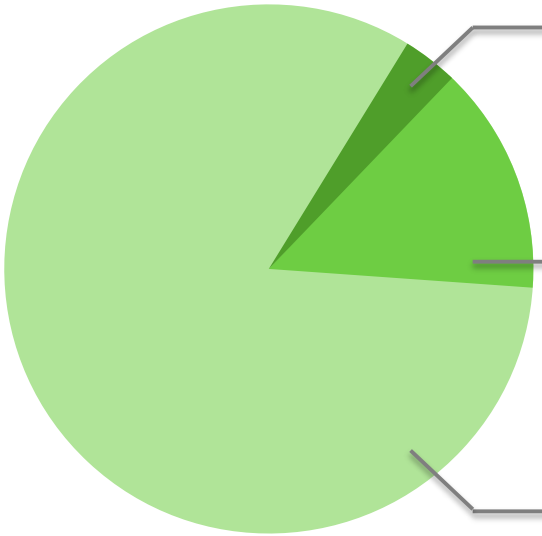


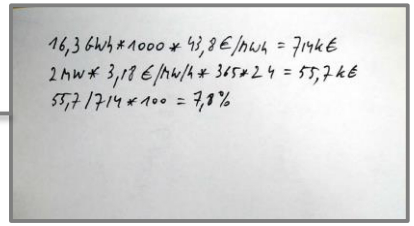


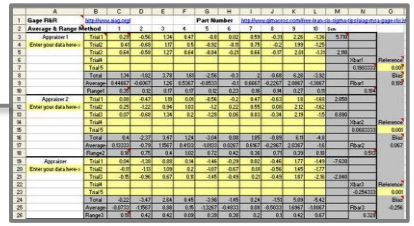


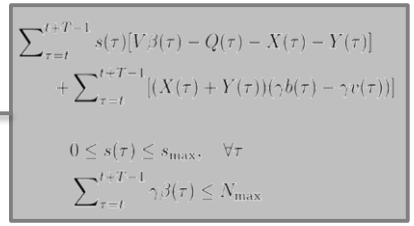
Business case calculation complexity …

business case calculation









Accuarcy of the business case value

"Building up interest in demand response is for many companies a long, time consuming, multi-stage process…"

Accuarcy of the business case value

"Building up interest in demand response is for many companies a long, time consuming, multi-stage process…"

… but an order of magnitude business case estimation is enough to plant a seed"

Requirements of a simplified methodology

1. Being cost effective and time efficient

Requirements of a simplified methodology

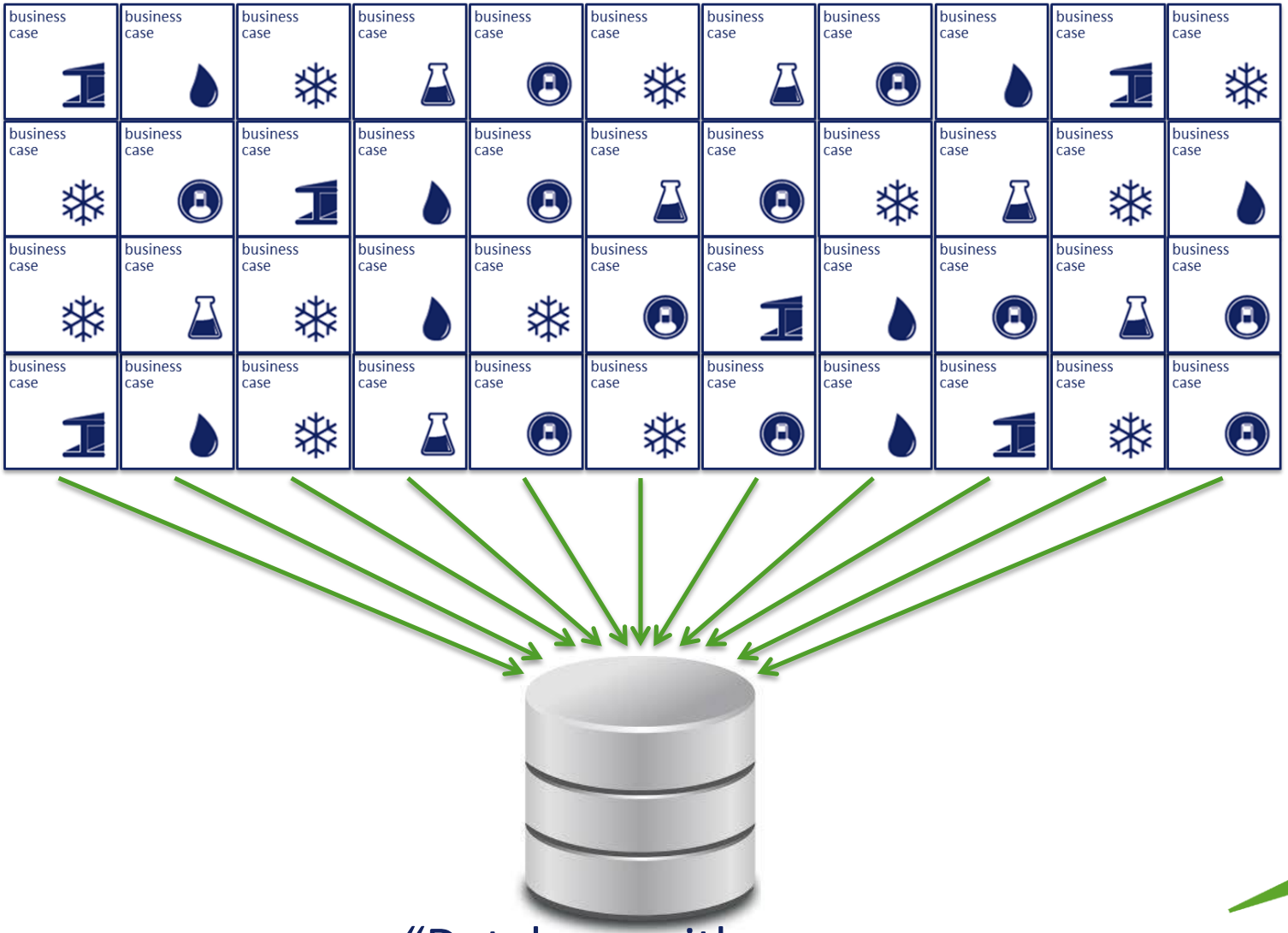
1. Being cost effective and time efficient
2. Order of magnitude accuracy estimation is good enough

Requirements of a simplified methodology

1. Being cost effective and time efficient
2. Order of magnitude accuracy estimation is good enough
3. No specific modelling and optimization knowledge and tools needed

Contents

The naïve approach …



"Database with many precalculated business cases"

A smarter approach … in 4 steps

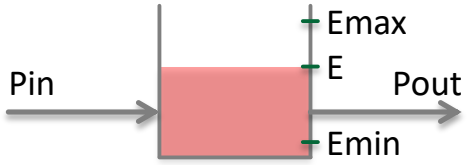
1. map
2. normalize
3. select
4. scale

A smarter approach … in 4 steps

1. map
2. normalize
3. select
4. scale

Example: generic battery model

generic
battery model



Example: generic battery model

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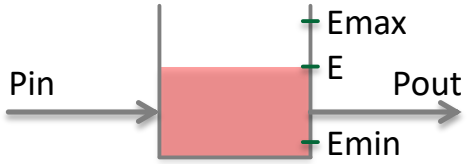
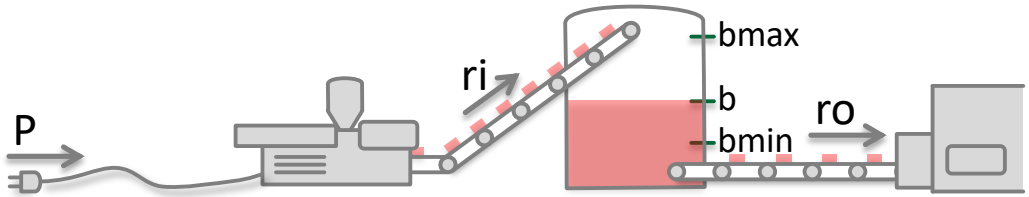
battery model



buffered
industrial process



Example: generic battery model

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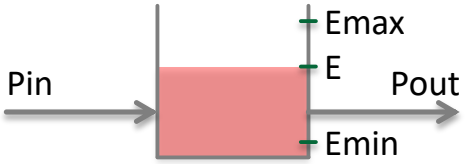
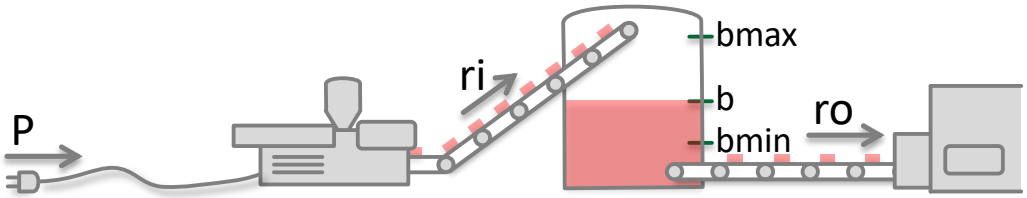
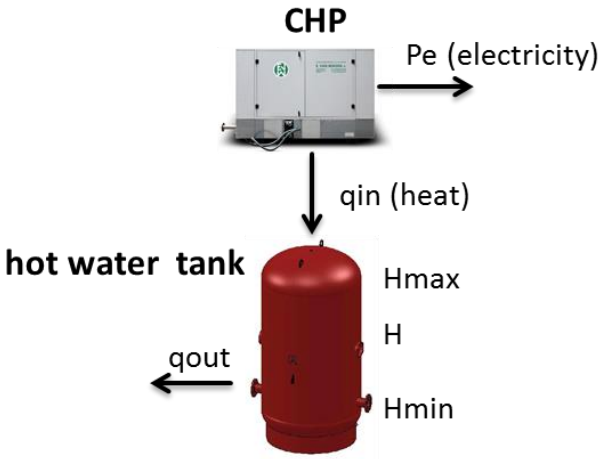
battery model



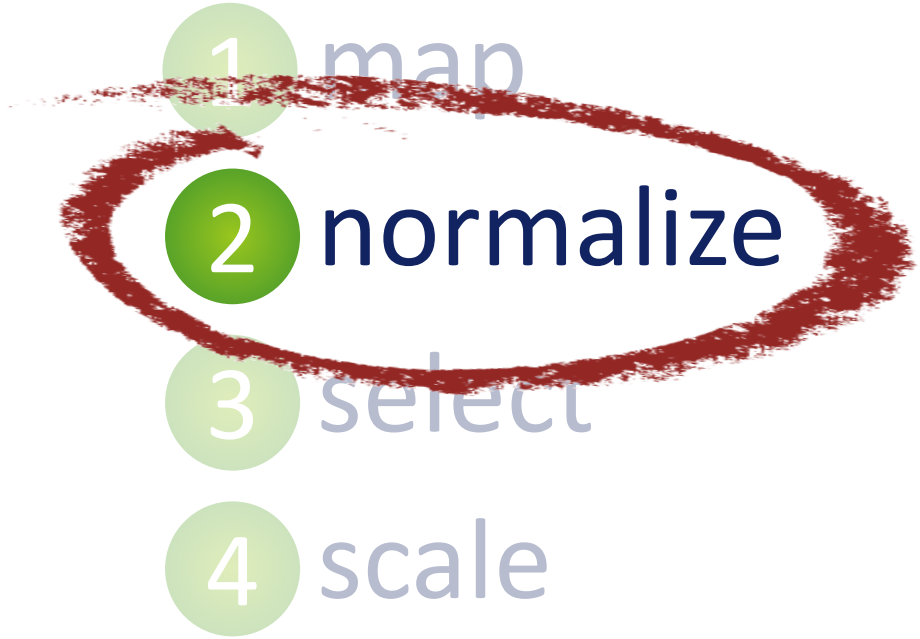
buffered
industrial process



CHP with a hot
water storage tank



A smarter approach … in 4 steps



Some properties scale very well …

2 normalize

1x

*"If you can earn **20€/year** by trading electricity on the day-ahead market with **1 car battery** … "*

*Pin = **2** kW*
*Pout = **2** kW*
*Emax = **1** kWh*

Some properties scale very well …

2 normalize

1x

20x

*"If you can earn **20€/year** by trading electricity on the day-ahead market with **1 car battery** … "*

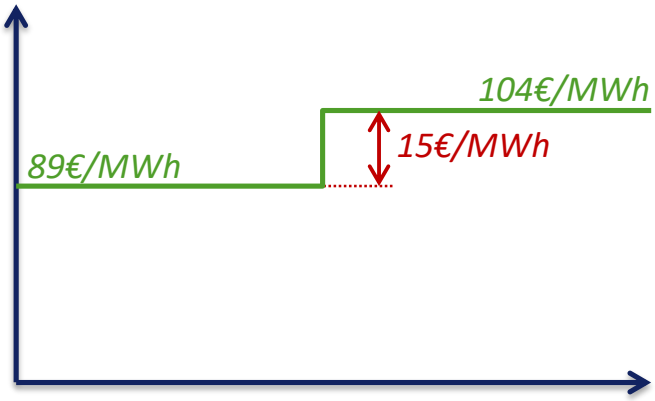
*Pin = **2** kW*
*Pout = **2** kW*
*Emax = **1** kWh*

*"… you can earn **400€/year** with **20 car batteries!**"*

*Pin = **40** kW*
*Pout = **40** kW*
*Emax = **20** kWh*

Some properties scale very well …

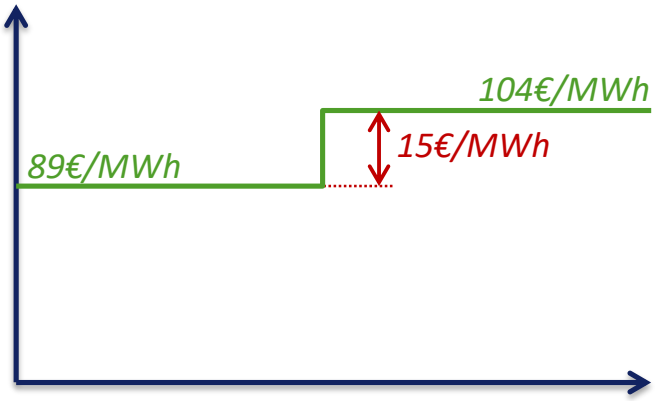
2 normalize

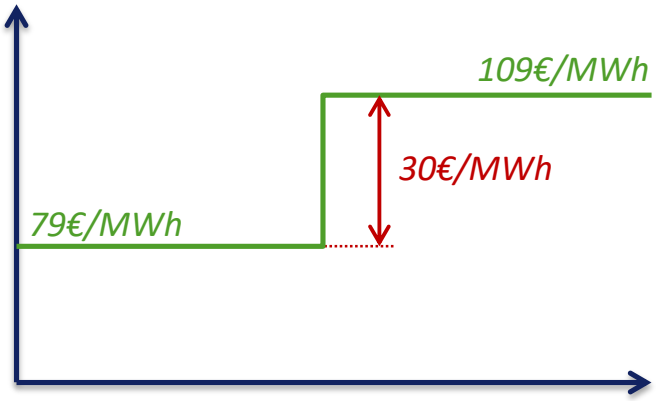


*"If you can earn **2.000€/year** by shifting electricity consumption from day to night … "*

Some properties scale very well …

2 normalize





*"If you can earn **2.000€/year** by shifting electricity consumption from day to night … "*

*"… you can earn **4.000€/year** in case the **price difference doubles** …"*

A smarter approach … in 4 steps

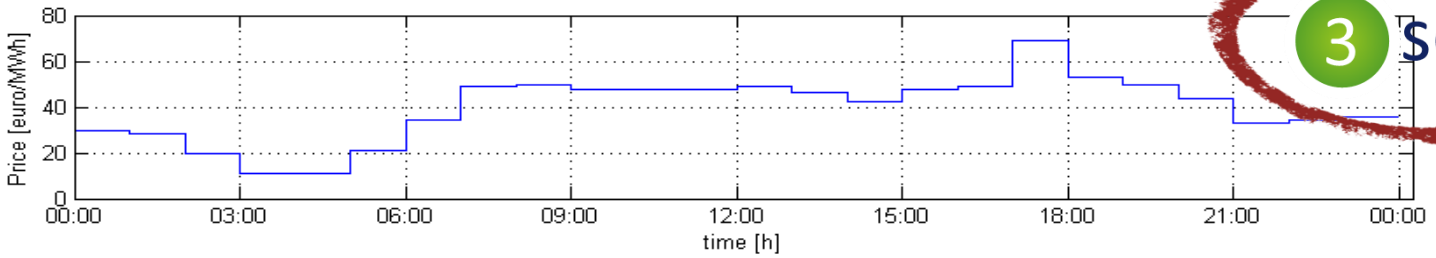
1 map

2 normalize

3 select

4 scale

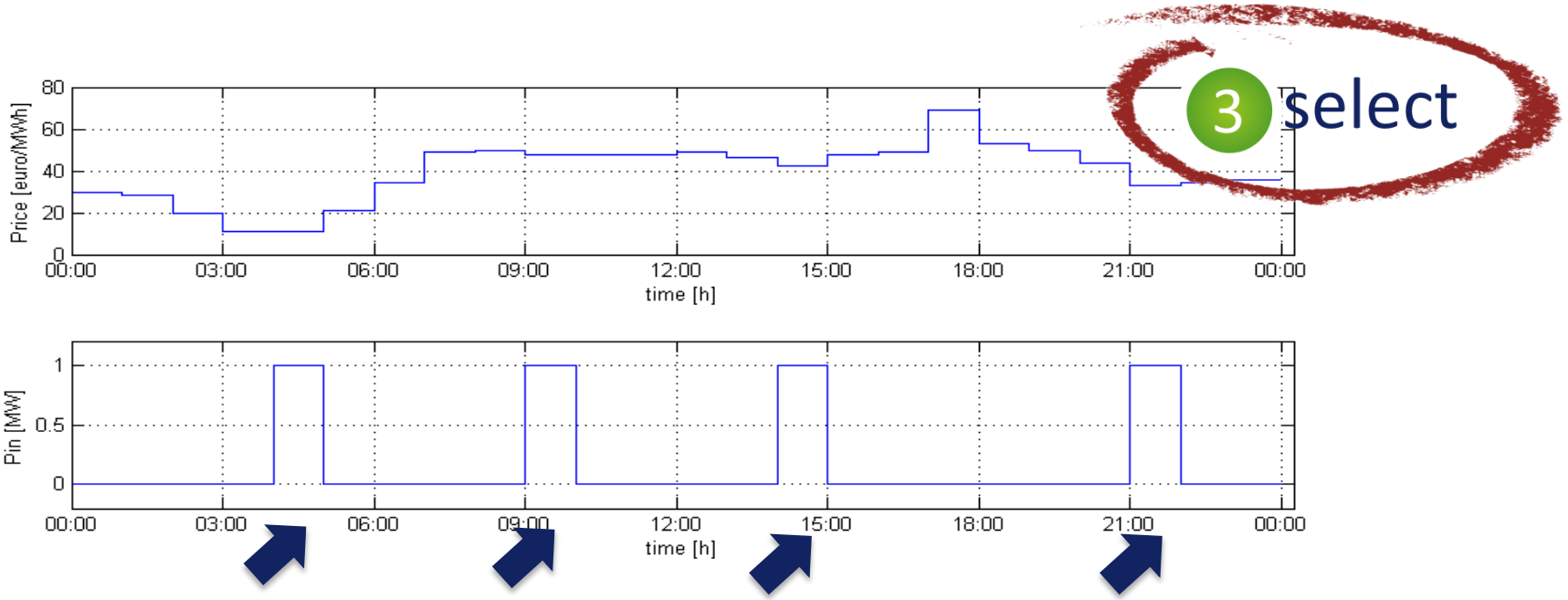
Making money with a “reference battery” on the day ahead market



3 select

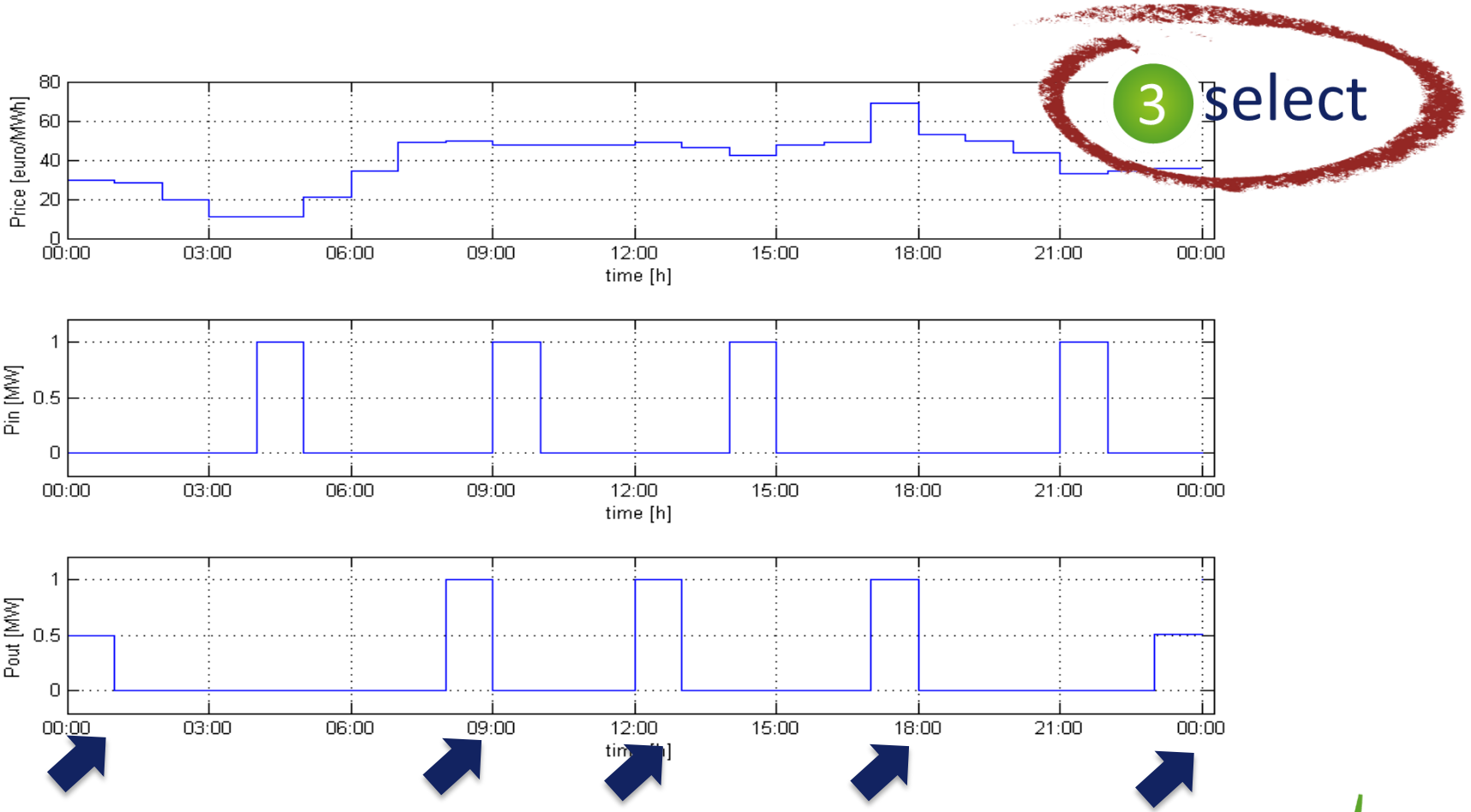
“Day ahead electricity price for 1 day …”

Making money with a "reference battery" on the day ahead market



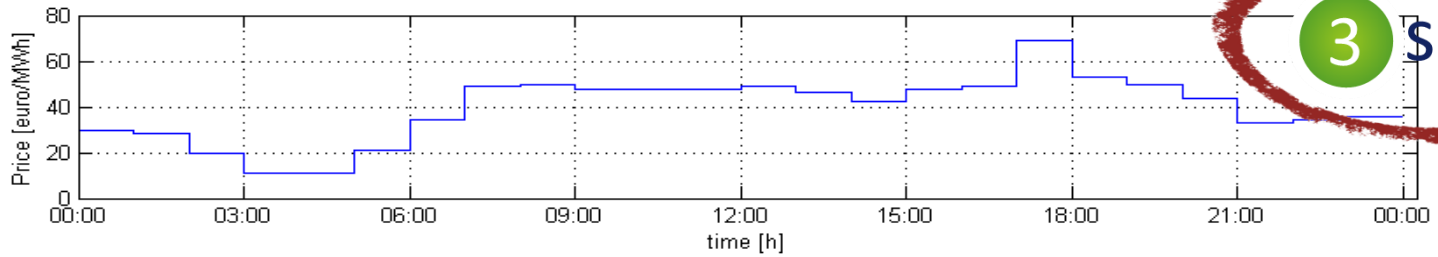
"Buy electricity when cheap …"

Making money with a "reference battery" on the day ahead market

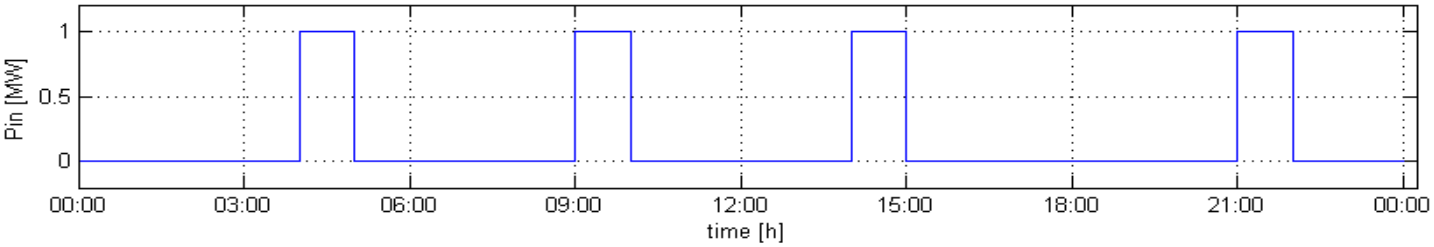


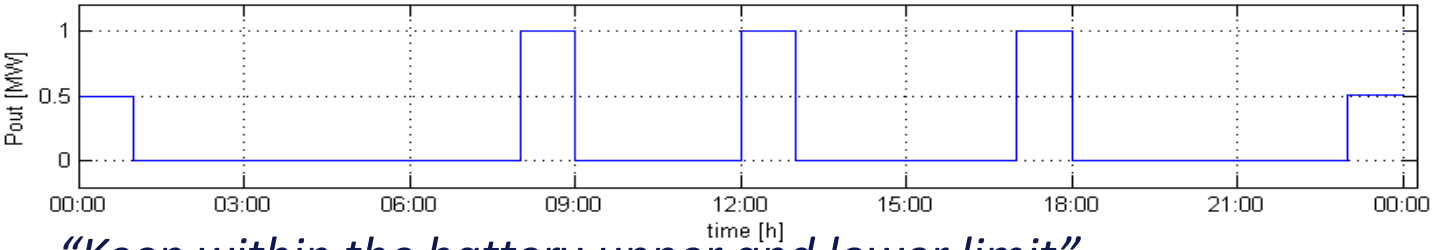
"Well electricity when expensive …"

Making money with a "reference battery" on the day ahead market

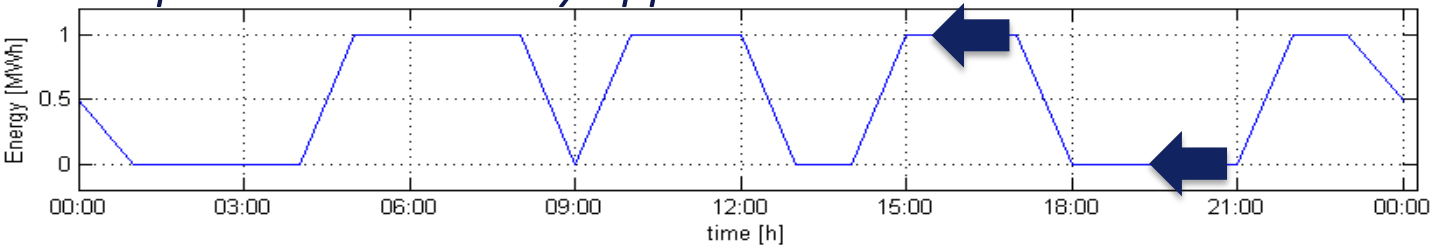


3 select

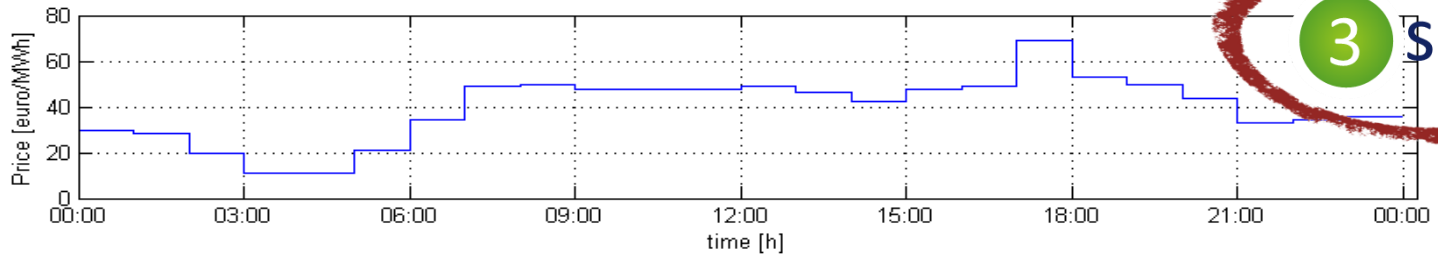




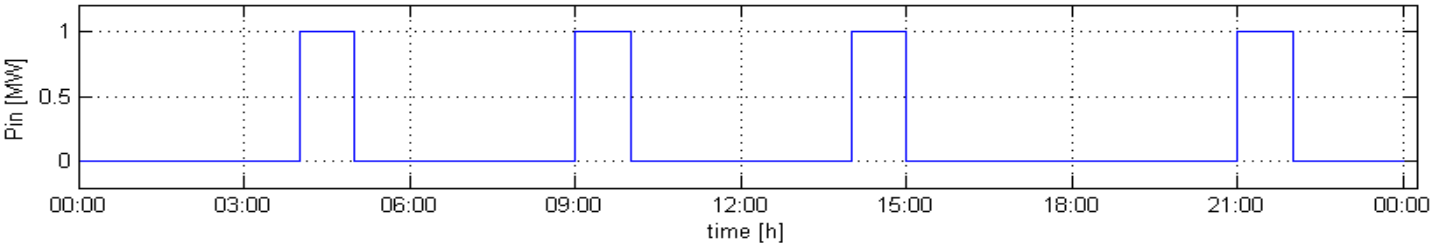
"Keep within the battery upper and lower limit"

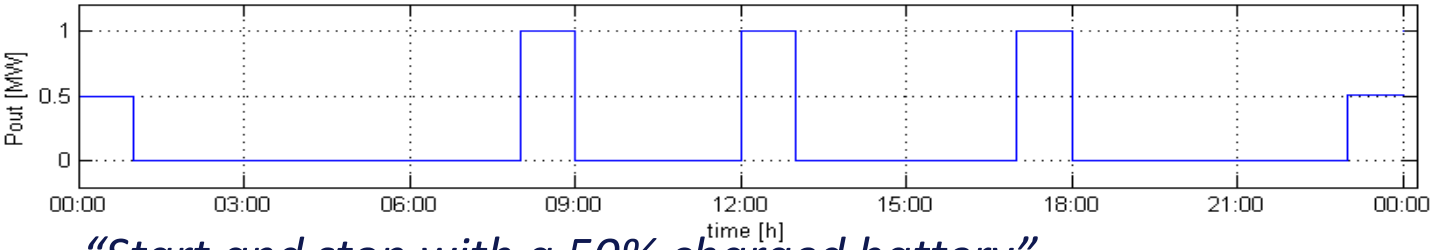


Making money with a "reference battery" on the day ahead market

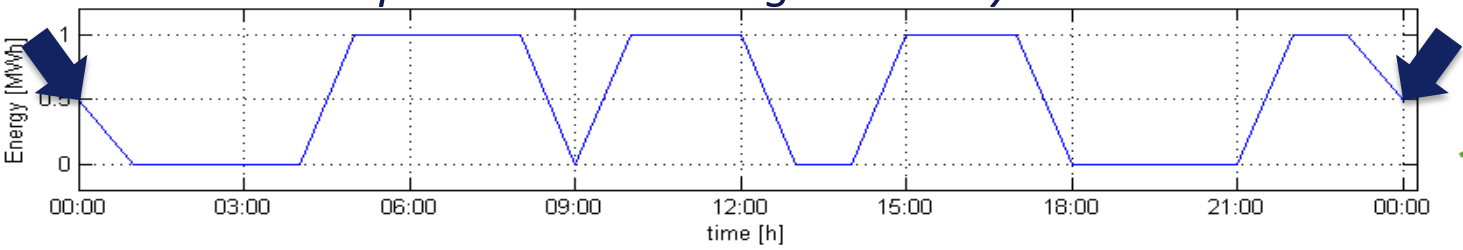


3 select





"Start and stop with a 50% charged battery"

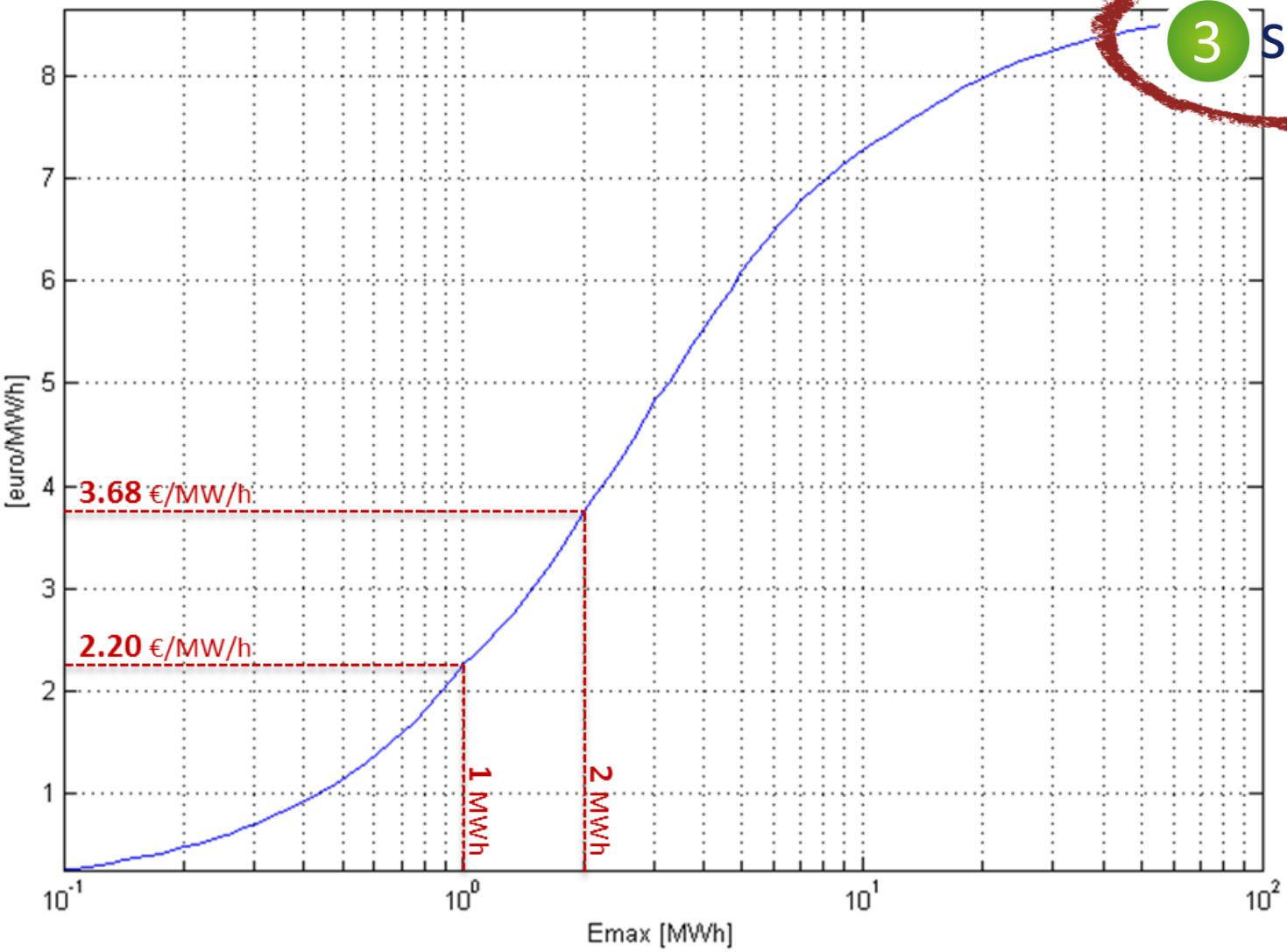


Making money with a "reference battery" on the day ahead market

- For 1 day in this example: profit = 66,16€
- For whole year: profit = 19.240€/year
- … or an average profit of **2,2€/MW/h**
- In case you double the battery size, but not the Pin and Pout, unfortunately this doesn't scale very well

"But why not putting it in a graph?"

The normalized business case graph



A smarter approach … in 4 steps

1 map

2 normalize

3 select

4 scale

Scale back to the real process parameters

4 scale

1x

20x

*"If you can earn **20€/year** by trading electricity on the day-ahead market with **1 car battery** … "*

*Pin = **2** kW*
*Pout = **2** kW*
*Emax = **1** kWh*

*"… you can earn **400€/year** with **20 car batteries!**"*

*Pin = **40** kW*
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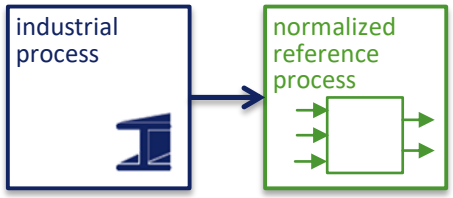
*Emax = **20** kWh*

Summary

"Starting point is an industrial process …"

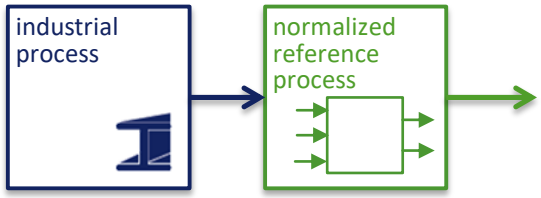
Summary



" … which will be mapped on a reference process …"

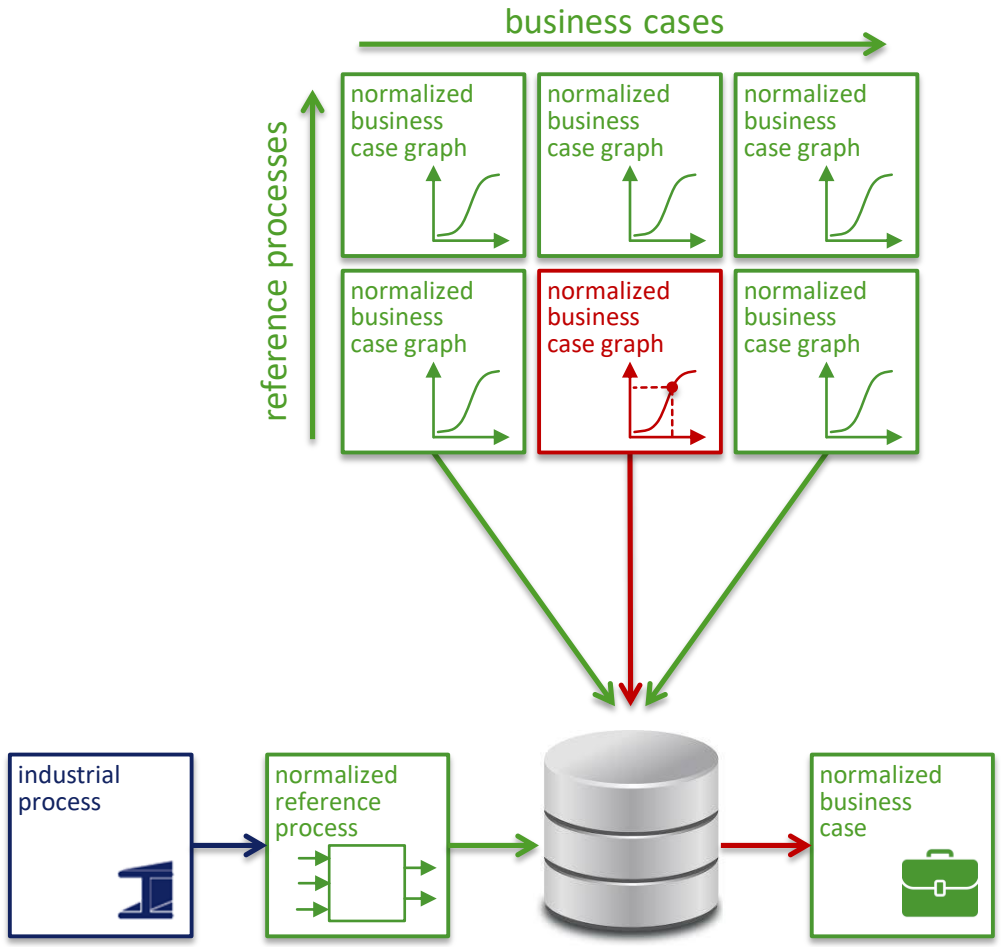
Summary

2 normalize



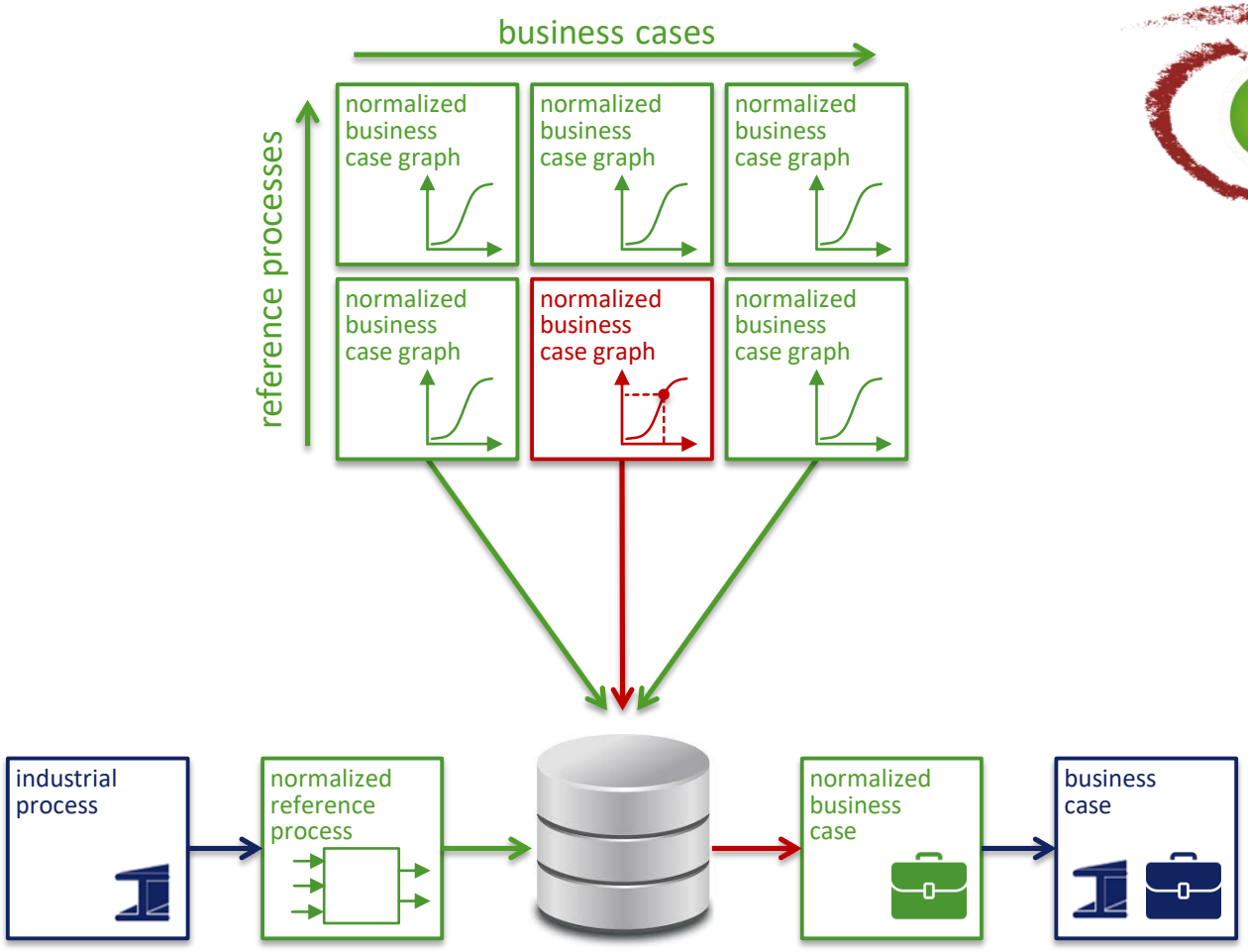
" … which is normalized to an 1MW equivalent …"

Summary



" … select the correct normalized business case graph and value … "

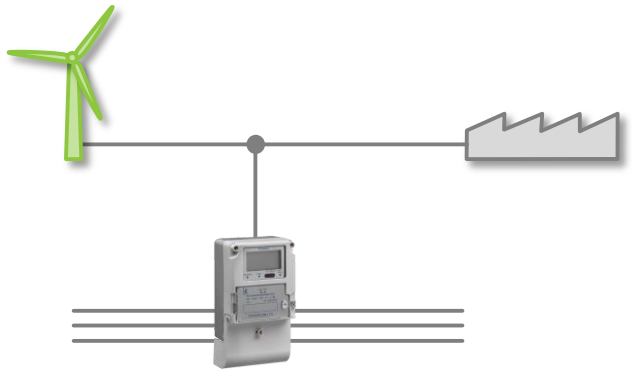
Summary



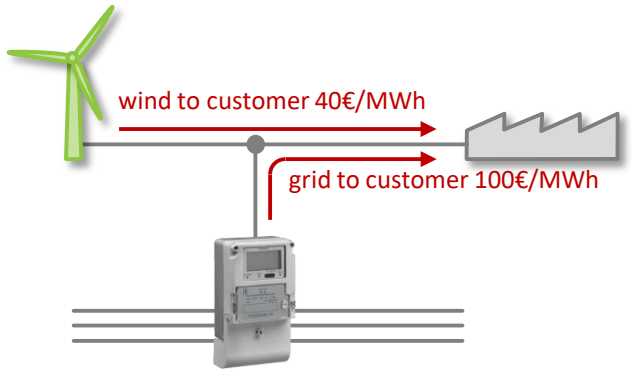
" … and scale back to the correct business case value."

Contents

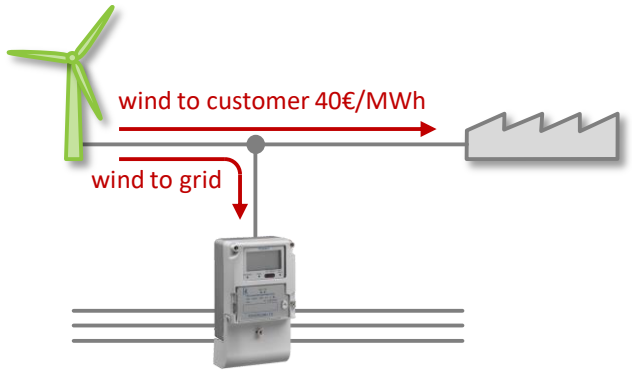
Configuration



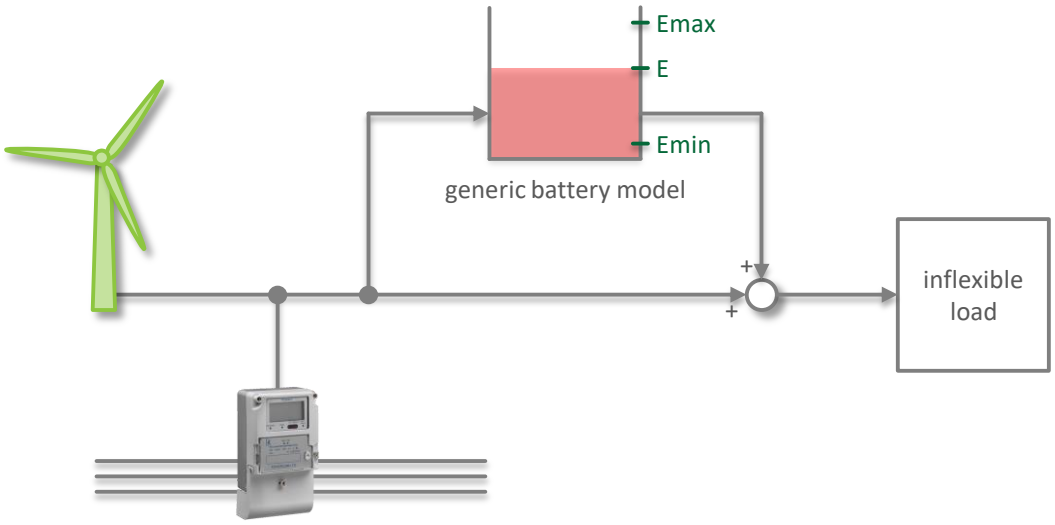
At low wind conditions



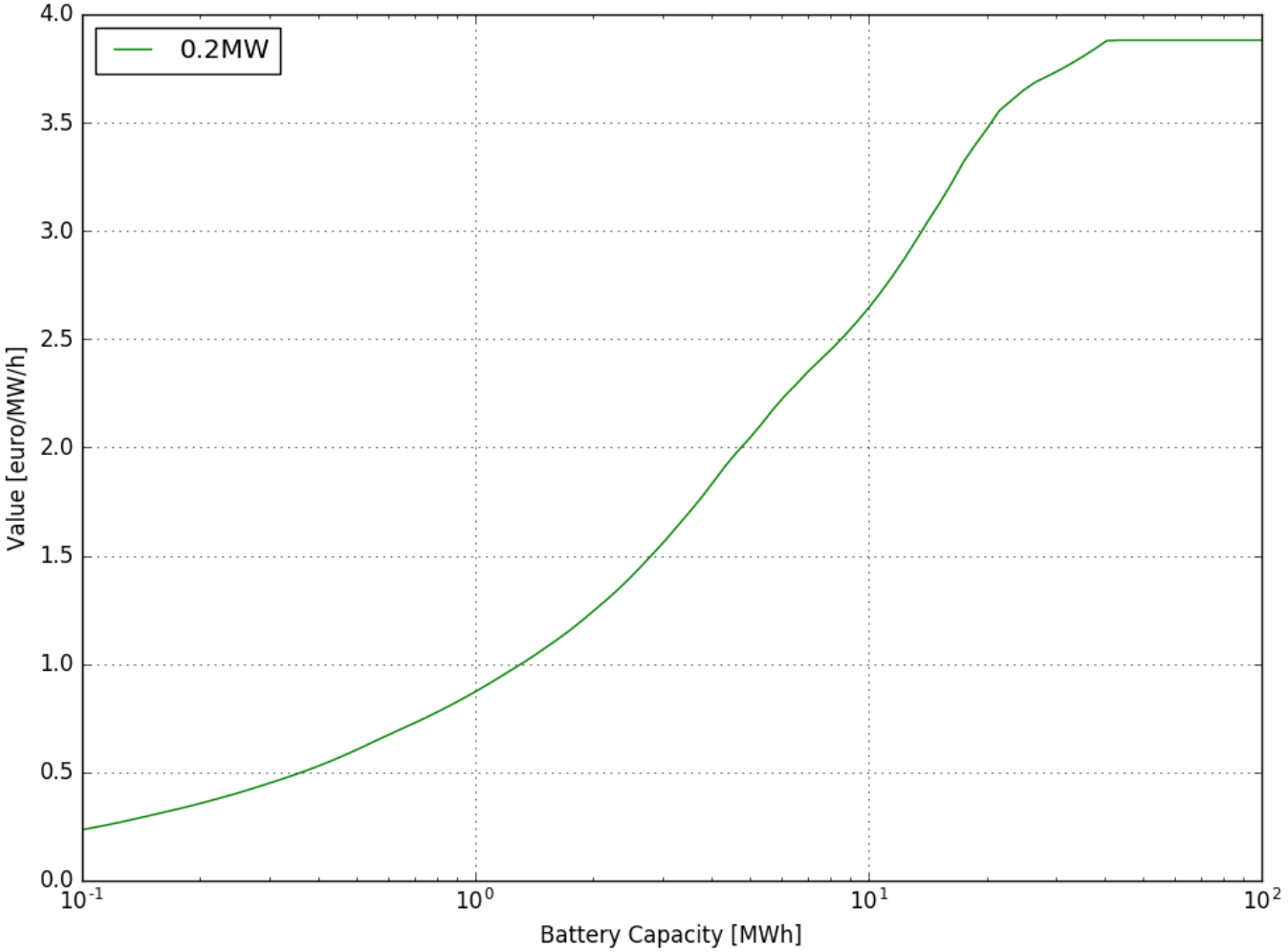
At high wind conditions



On-site VRE with the generic battery model

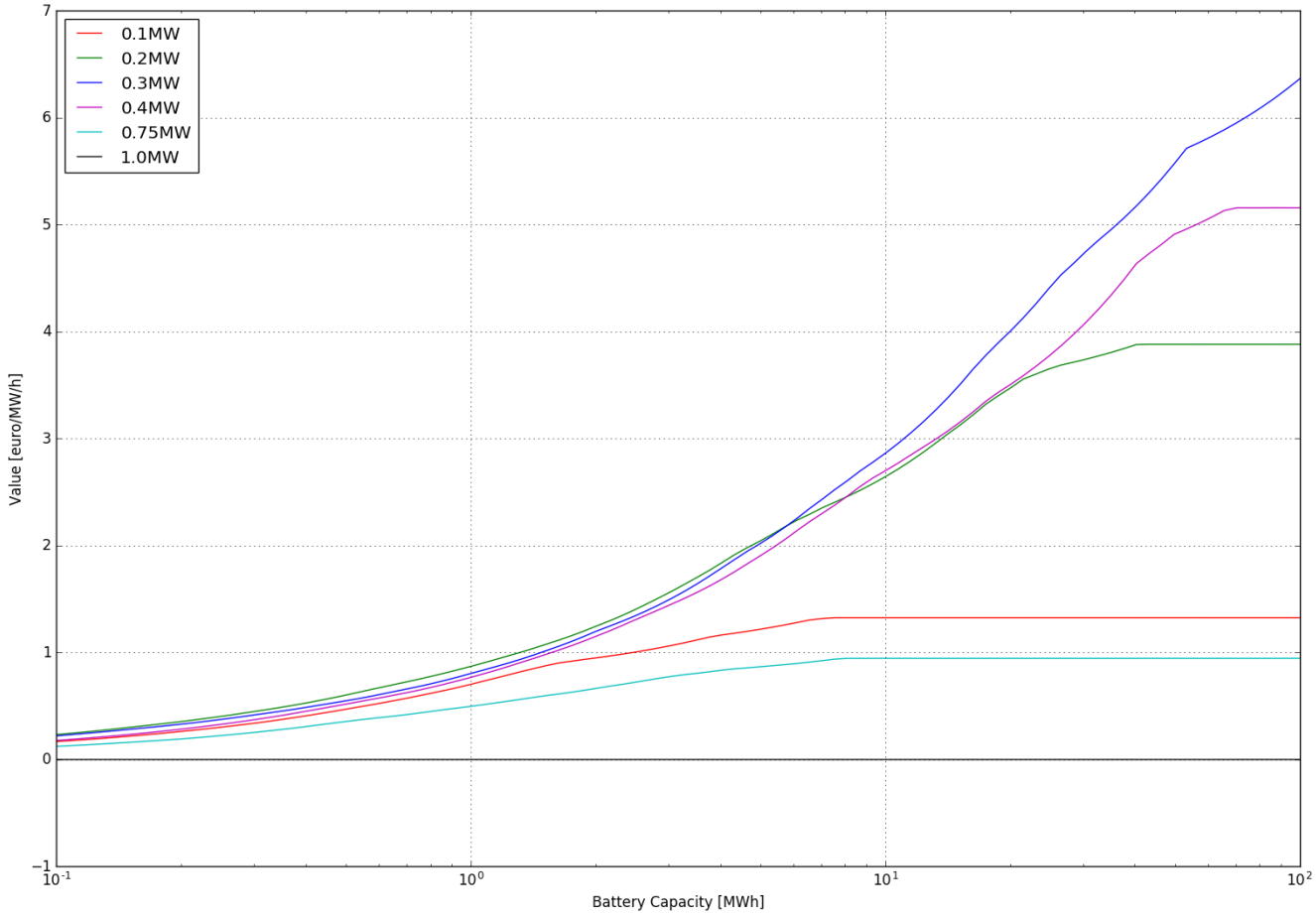


On-site VRE normalized business case graph



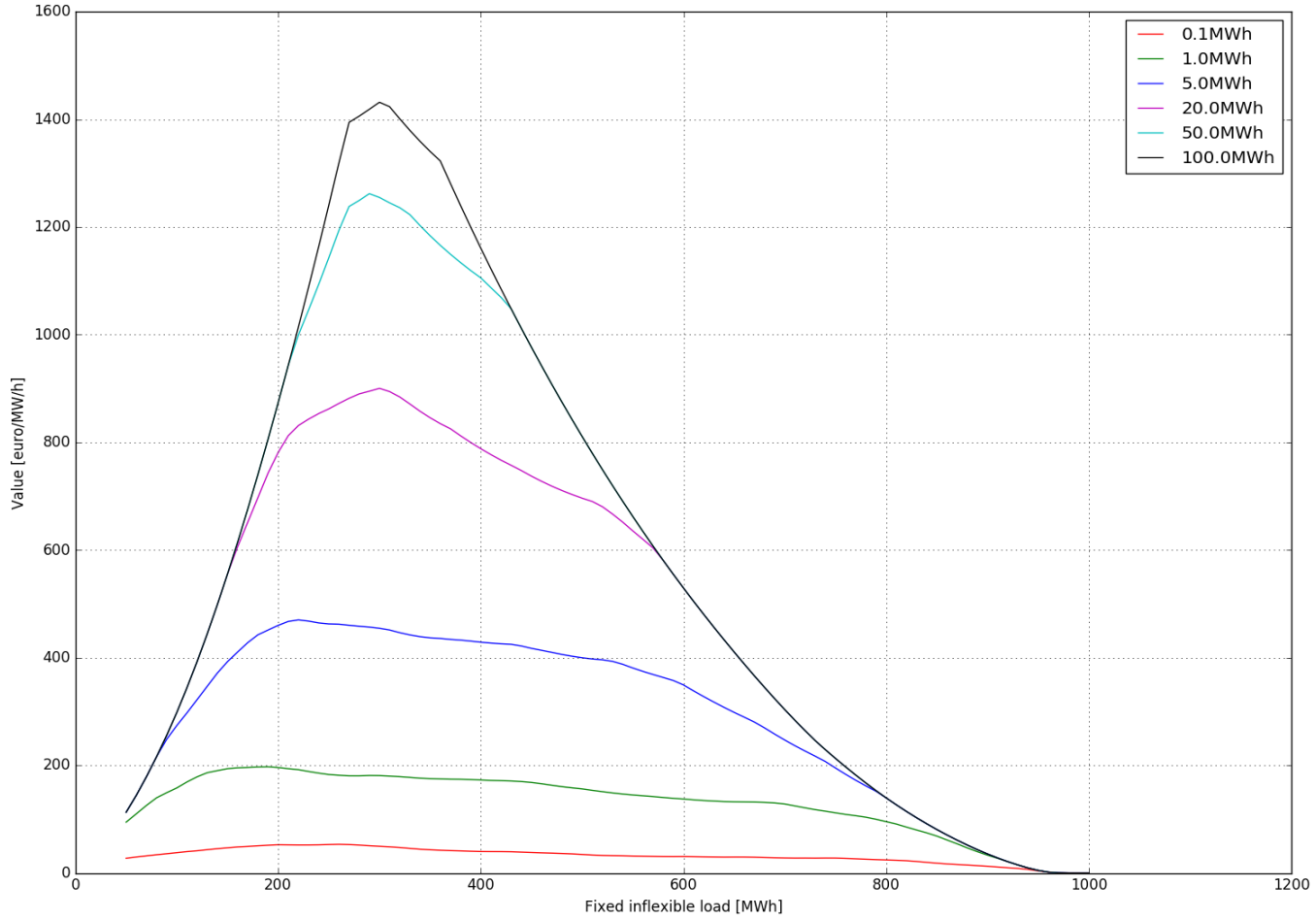
On-site VRE normalized business case graph

" … for different values of the fixed inflexible load."



On-site VRE normalized business case graph

" … and if you plot it differently,
you even see that there are optimal ratio's …"



Contents

Have the requirements been met?

1. Being cost effective and time efficient
2. Order of magnitude accuracy estimation is good enough
3. No specific modelling and optimization knowledge and tools needed

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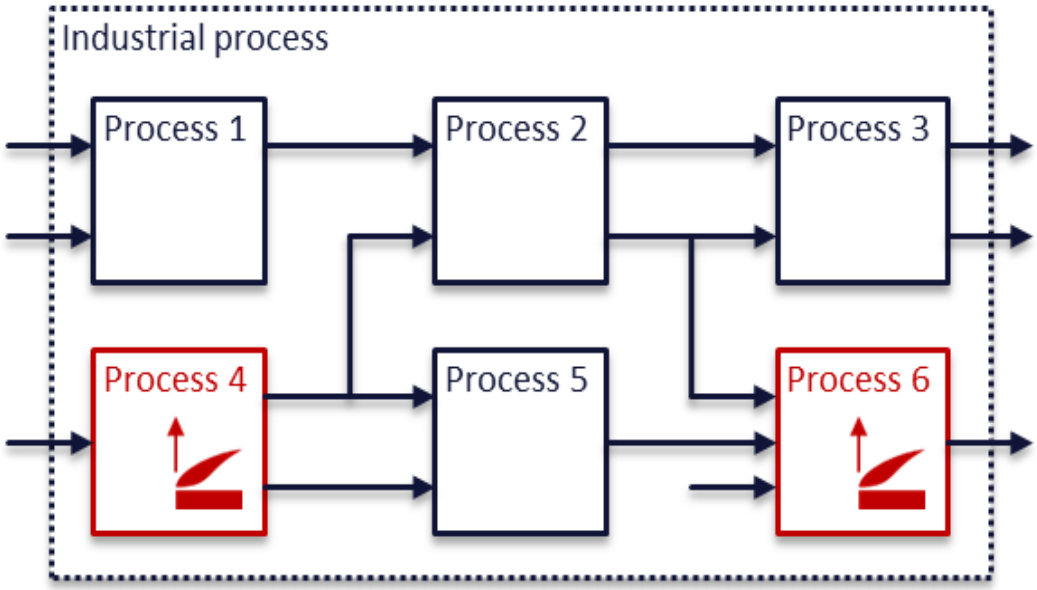
" Under the condition that the industrial process can be mapped on a relevant reference process, the approach is very straightforward "

Does this really work for complex cases?



BC value ≤ BC4 value + BC6 value

Next steps with the methodology

- Methodology will be tested and refined (if needed) during a **number of case studies**
- Case studies will take place **Q4-2016 till Q2-2017** in the **6** target countries

Call for interest

- This webinar is a **first information session**, showing you the potential of the methodology
- Mid 2017, a **hands-on workshop** will be organized → we'll keep you informed!
- Bringing this methodology to the market is **part of the IndustRE project**

Call for interest

Are you:

- An **engineering company** or **consultancy agency** with experience in **energy services**?
- **BRP**, **BSP** or **aggregator**?
- Interested in extending your portfolio with cost effective **demand response** business case advise?
- **Energy intensive industry** who wants to understand demand response opportunities yourself?

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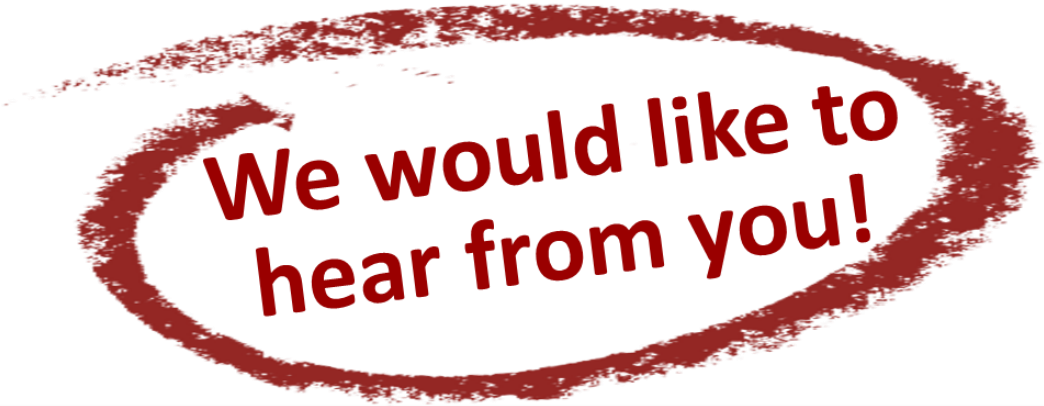

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