



industRE stakeholder meeting:

Methodology for optimal valorization of industrial flexible electricity consumption

*“Demand side flexibility
business case estimation
made easy ...”*

September 12, 2016

Jef Verbeeck - VITO/EnergyVille

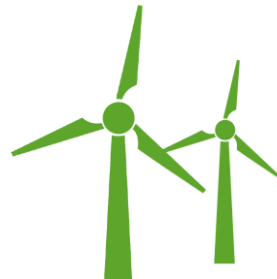


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Contents

- Part I How calculating a demand response business case?
- Part II The need for a simplified methodology
- Part III The simplified methodology step-by-step
- Part IV On-site renewable energy business case
- Part V Conclusions and further steps



Contents

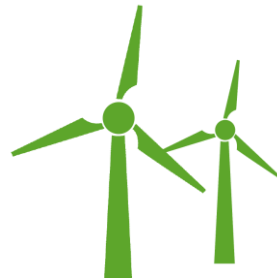
Part I How calculating a demand response business case?

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How can you make money with flexibility?

business
models



regulation



market data



flexibility
model



Business model

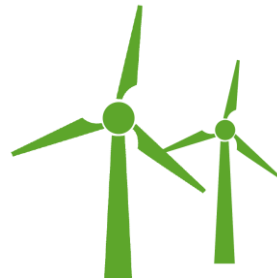
Standard contract optimization

Day-ahead optimization

Reserve capacity

Imbalance optimization

On-site VRE optimization



What is possible from a legal point of view?

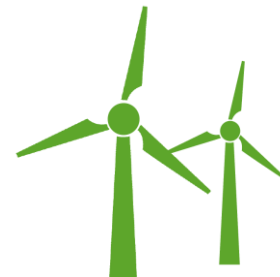


“Although EU guidelines are quite clear, implementation pace is different...”

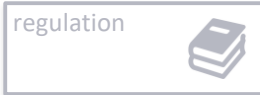


Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Day-ahead optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Reserve capacity	FC reserve	●	●	●	●	●	●
	FR reserve	●	●	●	●	●	●
	R reserve	●	●	●	●	●	●
Imbalance optimization	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

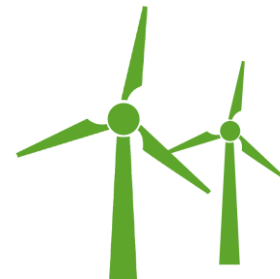
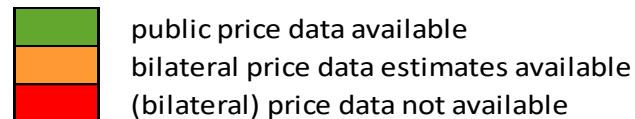
- business case is viable in existing regulatory framework
- business case limited viability/restricted in current regulatory framework
- business case impossible in existing regulatory framework



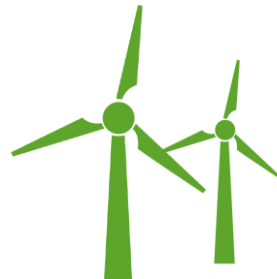
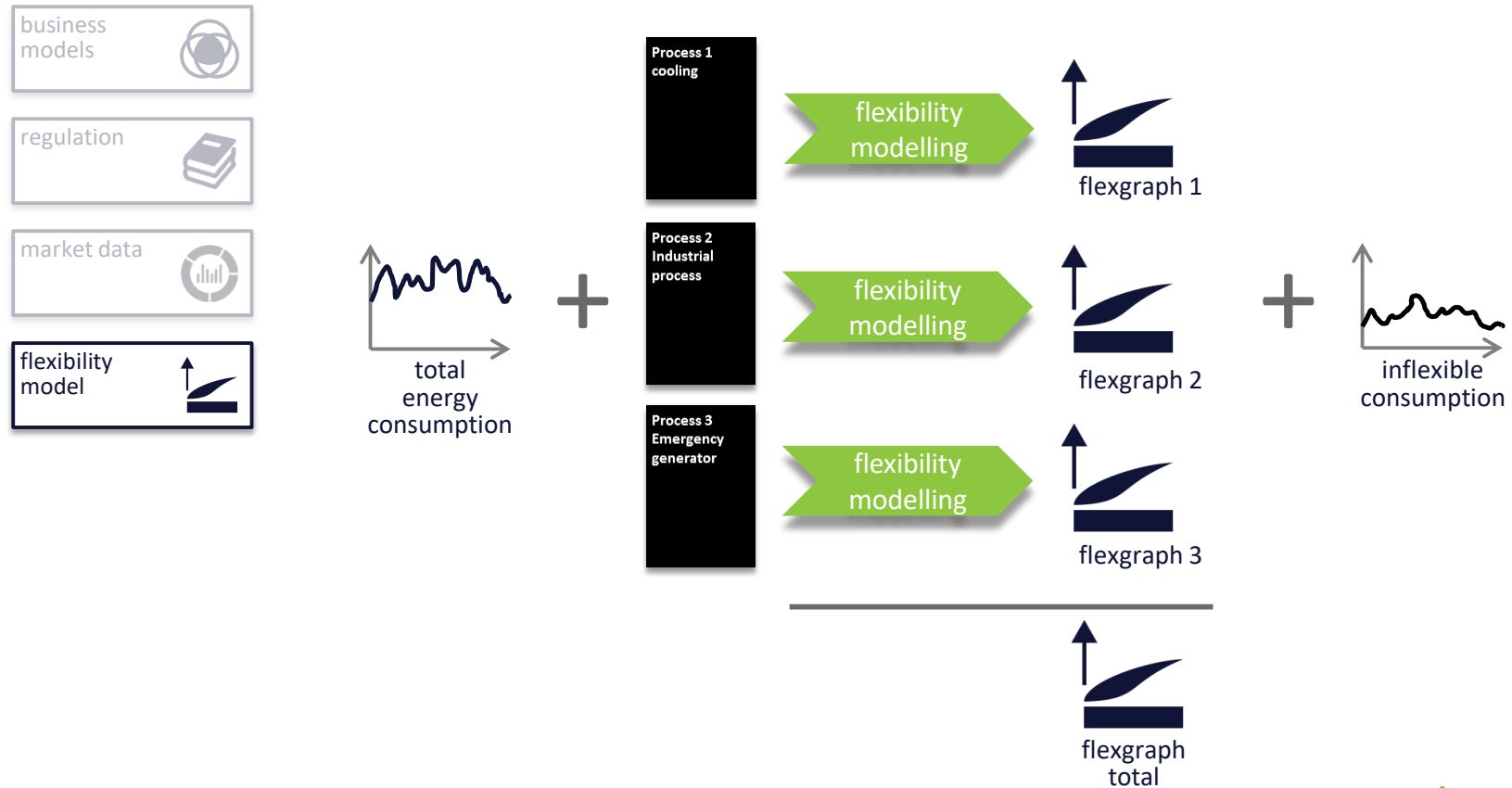
Which price data is available?



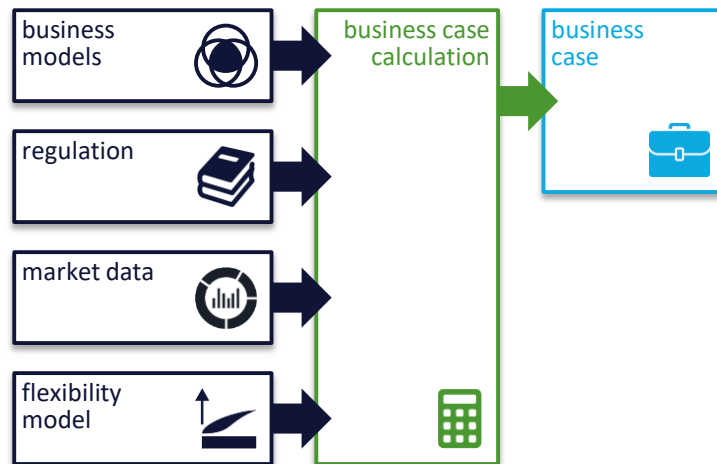
Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Day-ahead optimization	Commodity	●	●	●	●	●	●
	Network charges	●	●	●	●	●	●
Reserve capacity	FC reserve	●	●	●	●	●	●
	FR reserve	●	●	●	●	●	●
	R reserve	●	●	●	●	●	●
Imbalance optimization	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



How much flexibility is available?



Calculate the business case



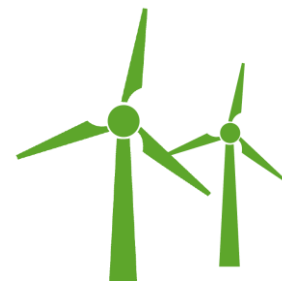
Business model		BE	FR	DE	IT	ES	UK
Standard contract optimization	Commodity	● PP	● PP	● PP	● PP	● PP	● PP
	Network charges	● PP	● PP	● PP	● PP	● PP	● PP
Day-ahead optimization	Commodity	● PP	● PP	● PP	● PP	● PP	● PP
	Network charges	● PP	● PP	● PP	● PP	● PP	● PP
Reserve capacity	FC reserve	● C	● C	● C	● -	● -	● 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

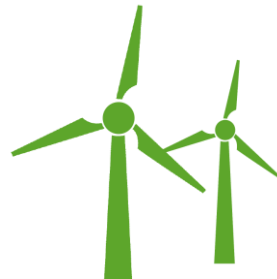
Part I How calculating a demand response business case?

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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

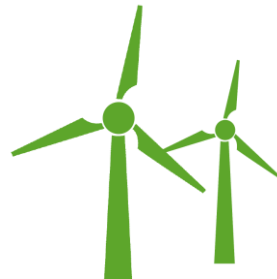
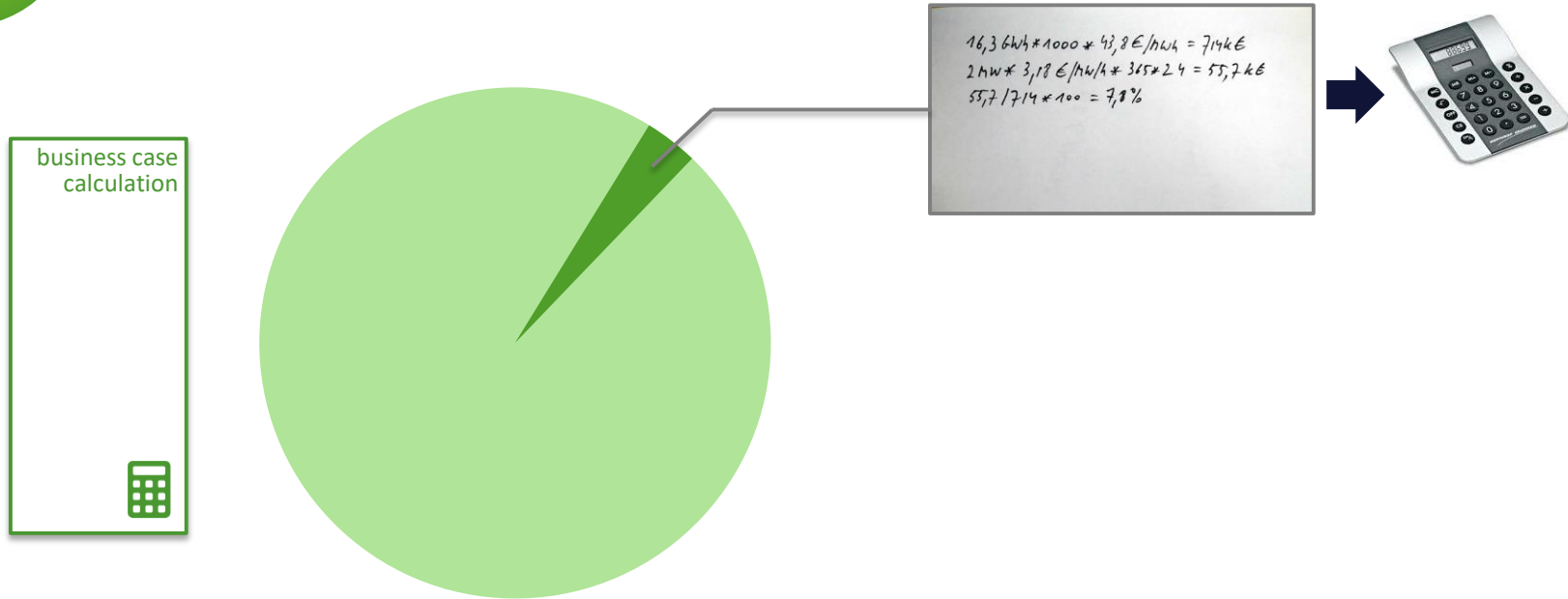
modelling stage:

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

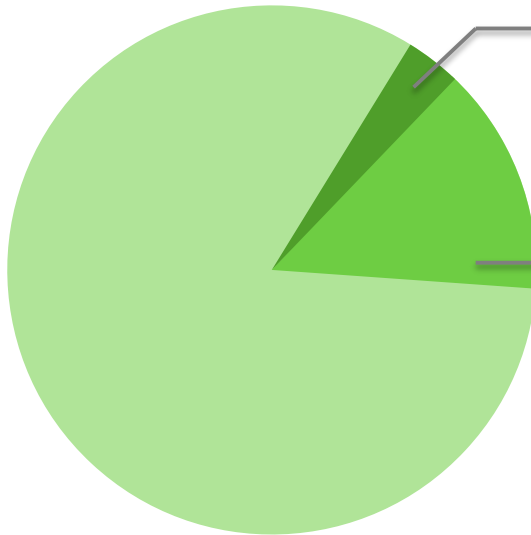
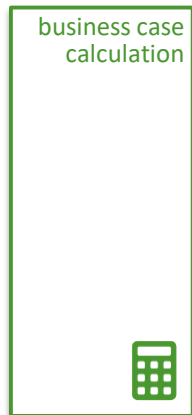
➔ The combination of skills is not so obvious



Business case calculation complexity ...



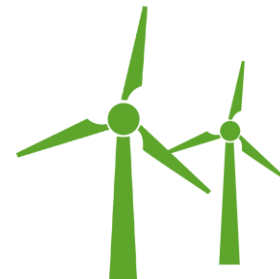
Business case calculation complexity ...

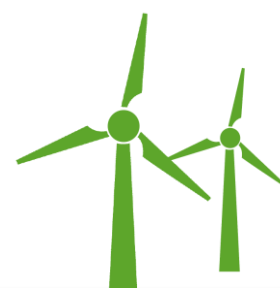


$$16,36 \text{ kWh} \times 1000 \times 43,8 \text{ €/MWh} = 714 \text{ €}$$
$$2 \text{ MW} \times 3,18 \text{ €/MWh} \times 365 \times 24 = 55,7 \text{ k€}$$
$$53,7 / 714 \times 100 = 7,5 \%$$



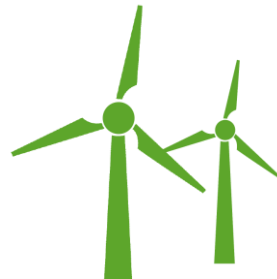
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Google Sheet	https://docs.google.com/spreadsheets/d/1aBcDeFgHiJkLmNoPqRsTuVwXyZ1234567890/edit#gid=0													
2	Project Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3	Project Description	This project aims to develop a new product line for the company, focusing on sustainable and eco-friendly materials.													
4	Project Manager	John Doe													
5	Project Start Date	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
6	Project End Date	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31	2023-12-31
7	Project Budget	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000	1000000
8	Project Status	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track	On Track
9	Project Risk	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
10	Project Impact	High	High	High	High	High	High	High	High	High	High	High	High	High	High
11	Project Review	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive
12	Project Conclusion	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful	Successful
13	Project Lessons Learned	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.	Clear communication is key.
14	Project Next Steps	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.	Monitor progress.
15	Project Contact	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe	John Doe
16	Project Version	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	Project Created	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
18	Project Modified	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
19	Project Deleted	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
20	Project Archived	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
21	Project Published	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
22	Project Unpublished	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
23	Project Draft	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
24	Project Final	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
25	Project Cancelled	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
26	Project Suspended	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
27	Project Resumed	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
28	Project Completed	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
29	Project Archived	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01
30	Project Deleted	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01	2023-01-01





Accuarcy of the business case value

“Building up interest in demand response is for many companies a long, time consuming, multi-stage process...”

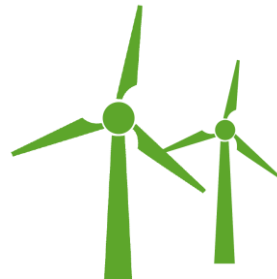


Accuracy of the business case value

“Building up interest in demand response is for many companies a long, time consuming, multi-stage process...”



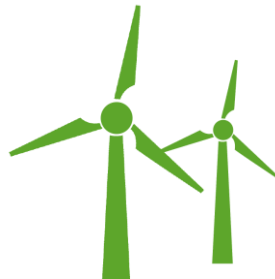
... but an order of magnitude business case estimation is enough to plant a seed”



Requirements of a simplified methodology

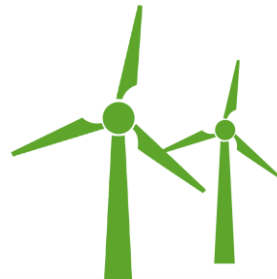
1

Being cost effective and time efficient



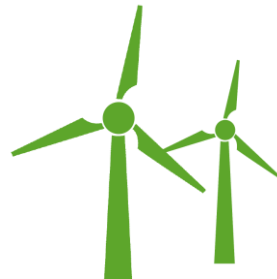
Requirements of a simplified methodology

- 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

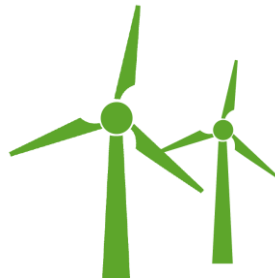
Part I How calculating a demand response business case?

Part II The need for a simplified methodology













































Part III The simplified methodology step-by-step

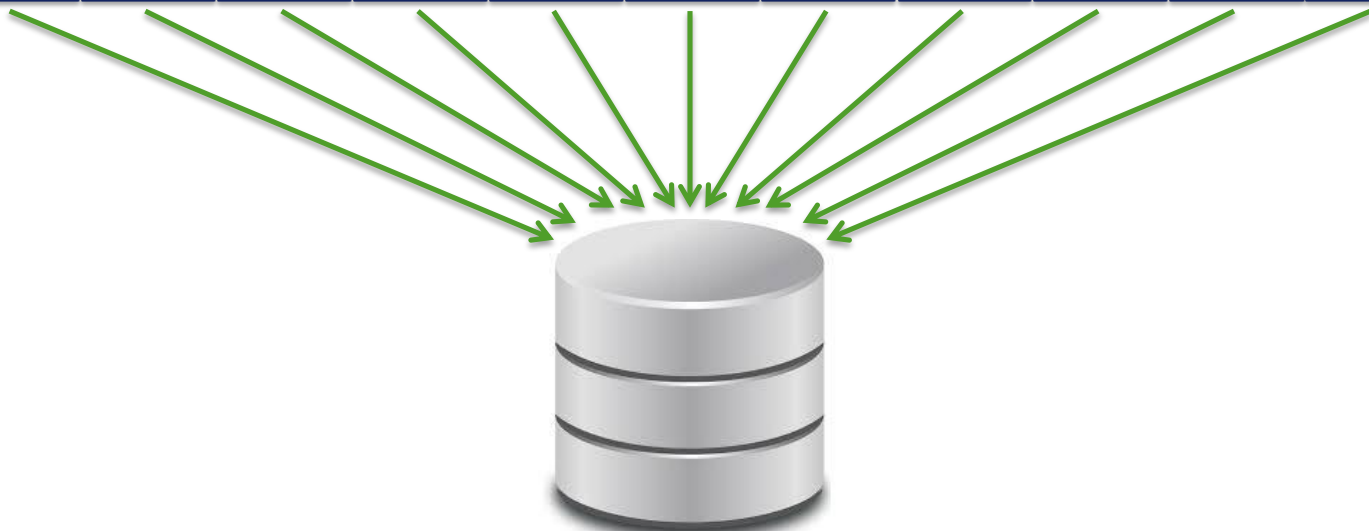
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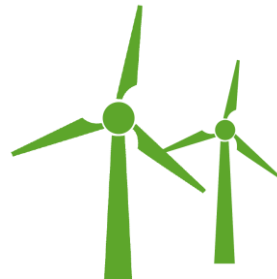


The naïve approach ...

business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 
business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 
business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 	business case 
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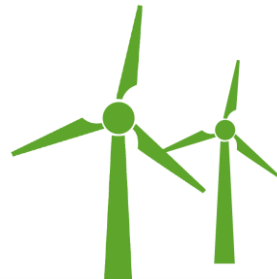


“Database with many
precalculated business cases”



A smarter approach ... in 4 steps

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



A smarter approach ... in 4 steps

1

map

2

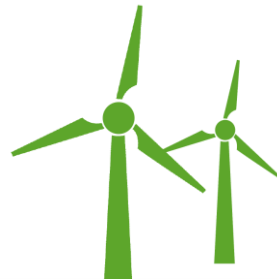
normalize

3

select

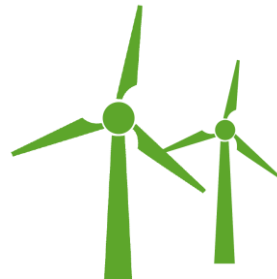
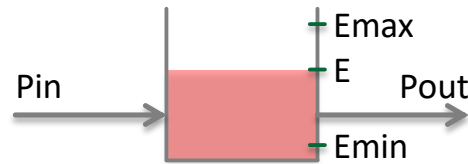
4

scale



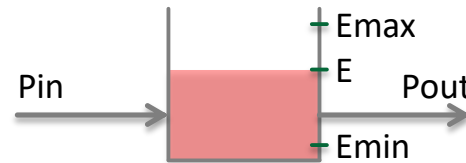
Example: generic battery model

generic
battery model

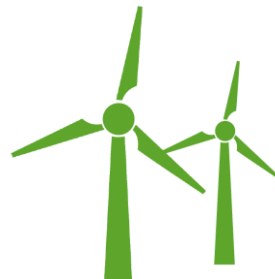
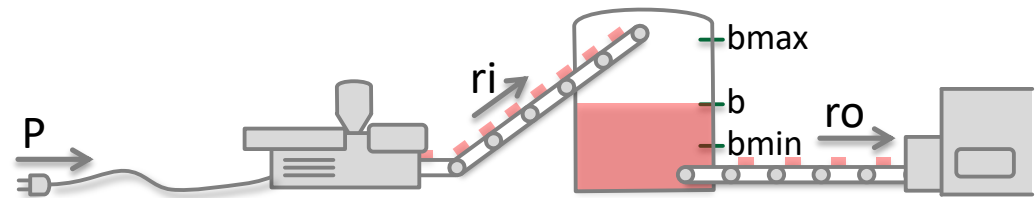


Example: generic battery model

generic
battery model

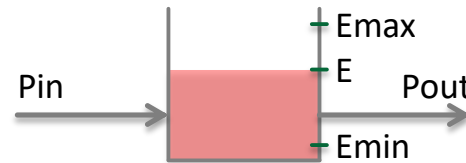


buffered
industrial process

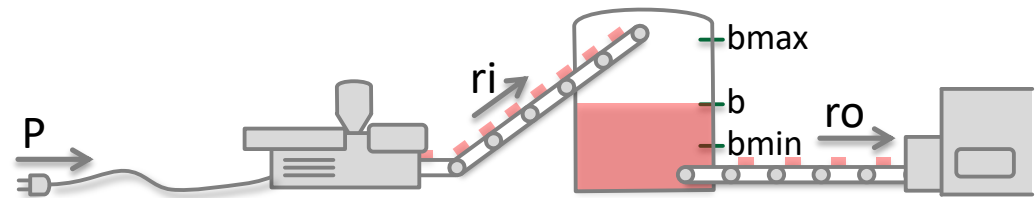


Example: generic battery model

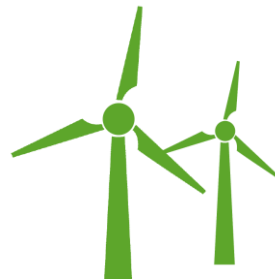
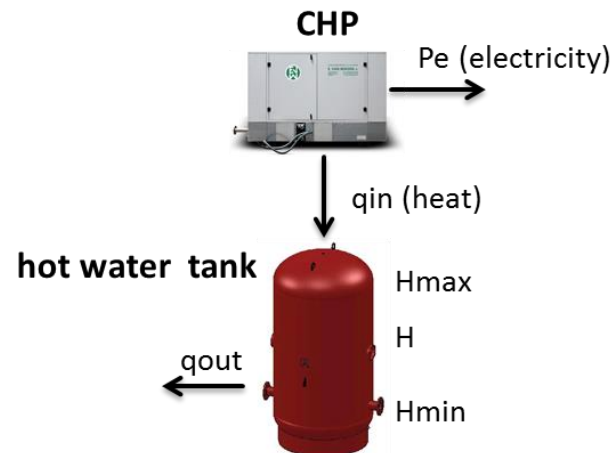
generic
battery model



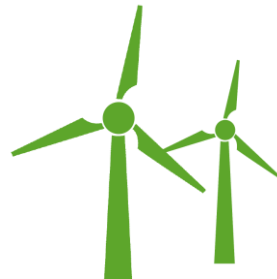
buffered
industrial process



CHP with a hot
water storage tank



A smarter approach ... in 4 steps



Some properties scale very well ...

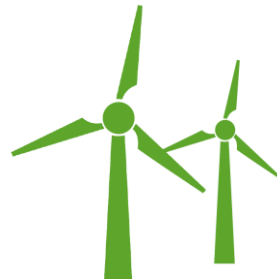
2 normalize

1x



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

*$P_{in} = 2 \text{ kW}$
 $P_{out} = 2 \text{ kW}$
 $E_{max} = 1 \text{ kWh}$*



Some properties scale very well ...

2 normalize

1x



20x

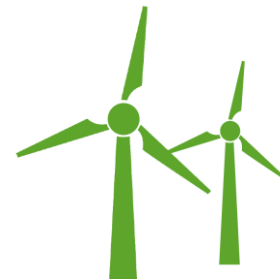


*“If you can earn **20€/year** by trading electricity on the day-ahead market with **1 car battery** ... “*

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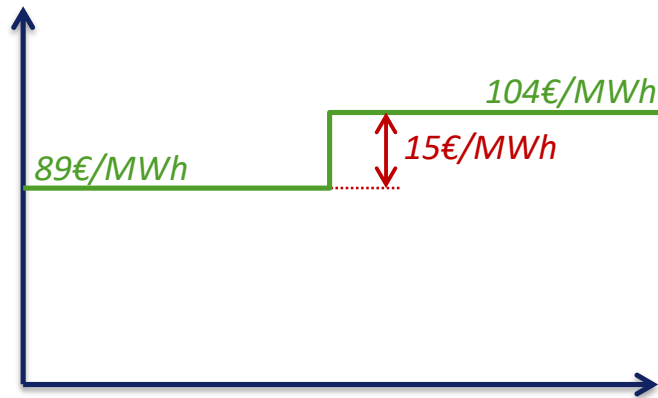
*“... you can earn **400€/year** with **20 car batteries!**“*

*$P_{in} = 40 \text{ kW}$
 $P_{out} = 40 \text{ kW}$
 $E_{max} = 20 \text{ kWh}$*

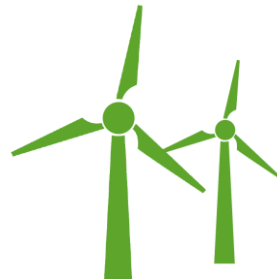


Some properties scale very well ...

2 normalize

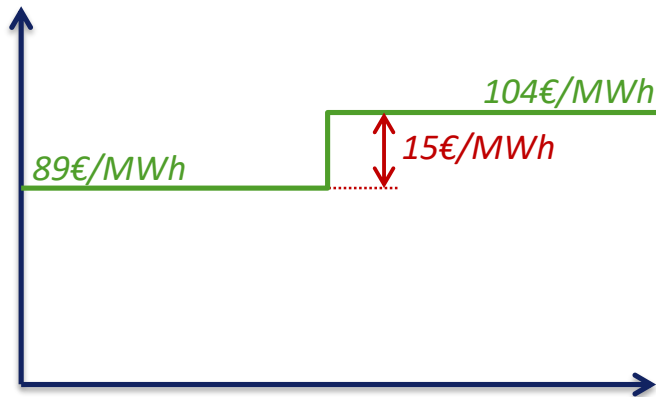


*“If you can earn **2.000€/year** by shifting electricity consumption from day to night ... ”*

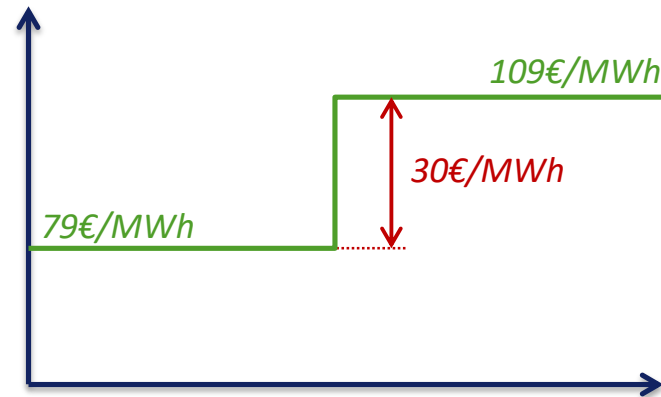


Some properties scale very well ...

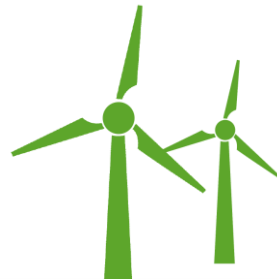
2 normalize



*“If you can earn **2.000€/year** by shifting electricity consumption from day to night ...”*

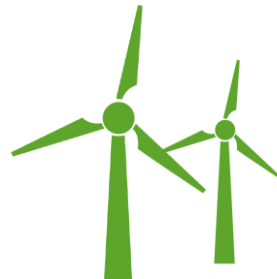


*“... you can earn **4.000€/year** in case the **price difference doubles ...**”*

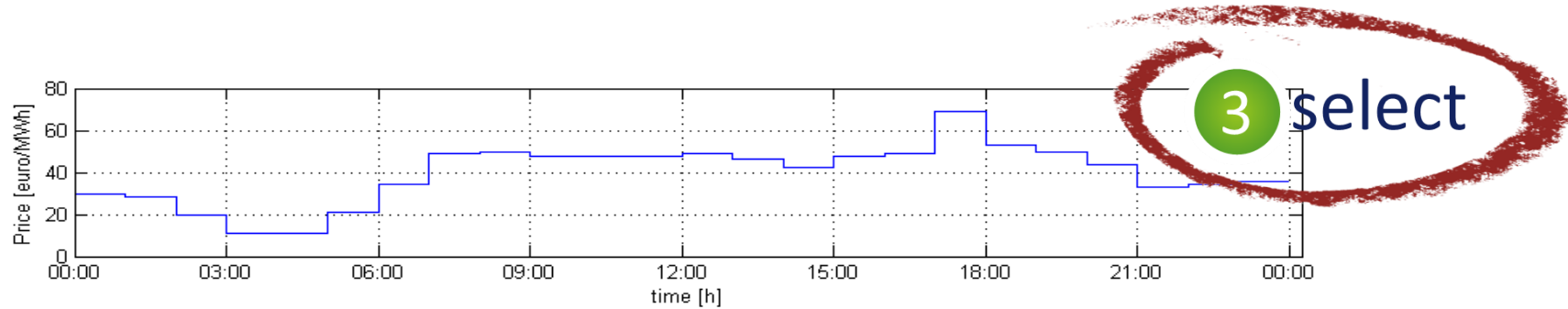


A smarter approach ... in 4 steps

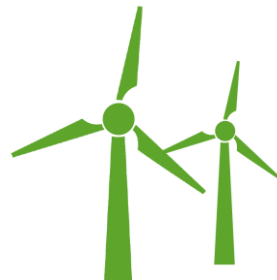
- 1 map
- 2 normalize
- 3 select**
- 4 scale



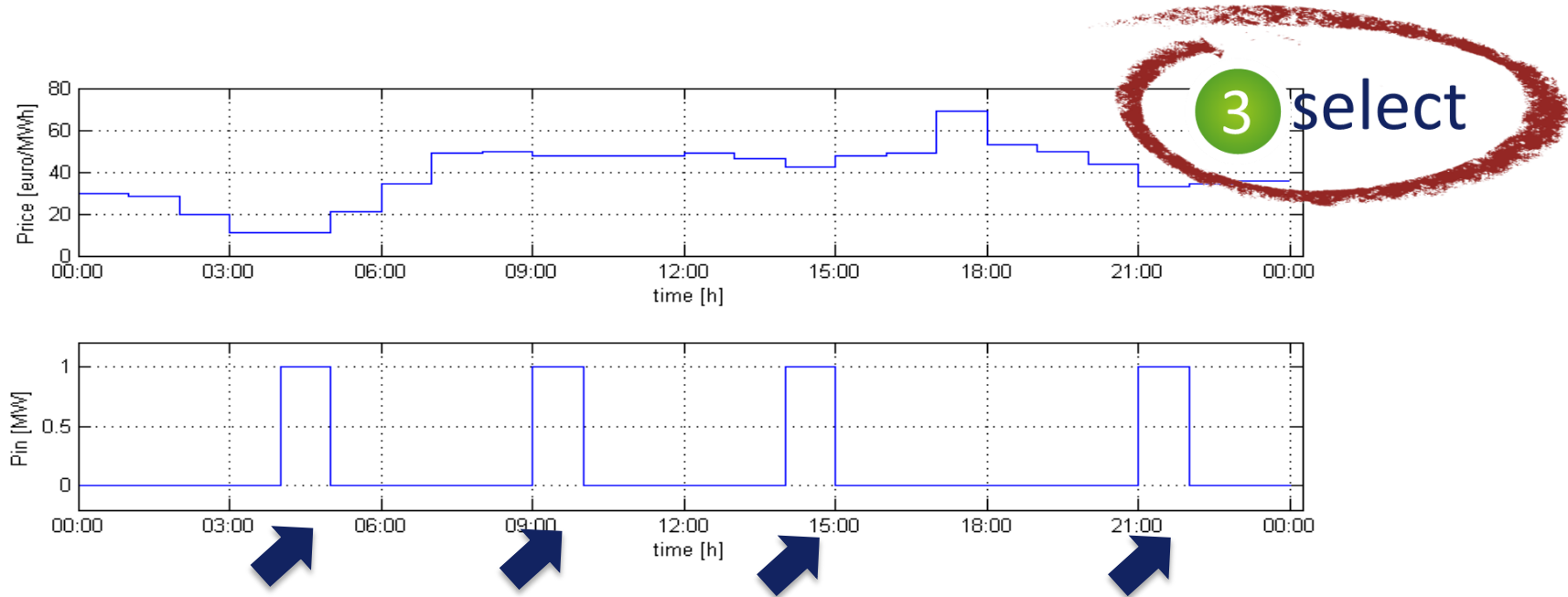
Making money with a “reference battery” on the day ahead market



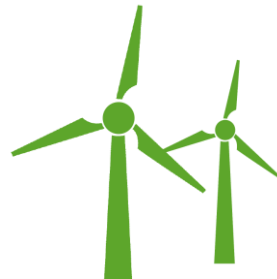
“Day ahead electricity price for 1 day ...”



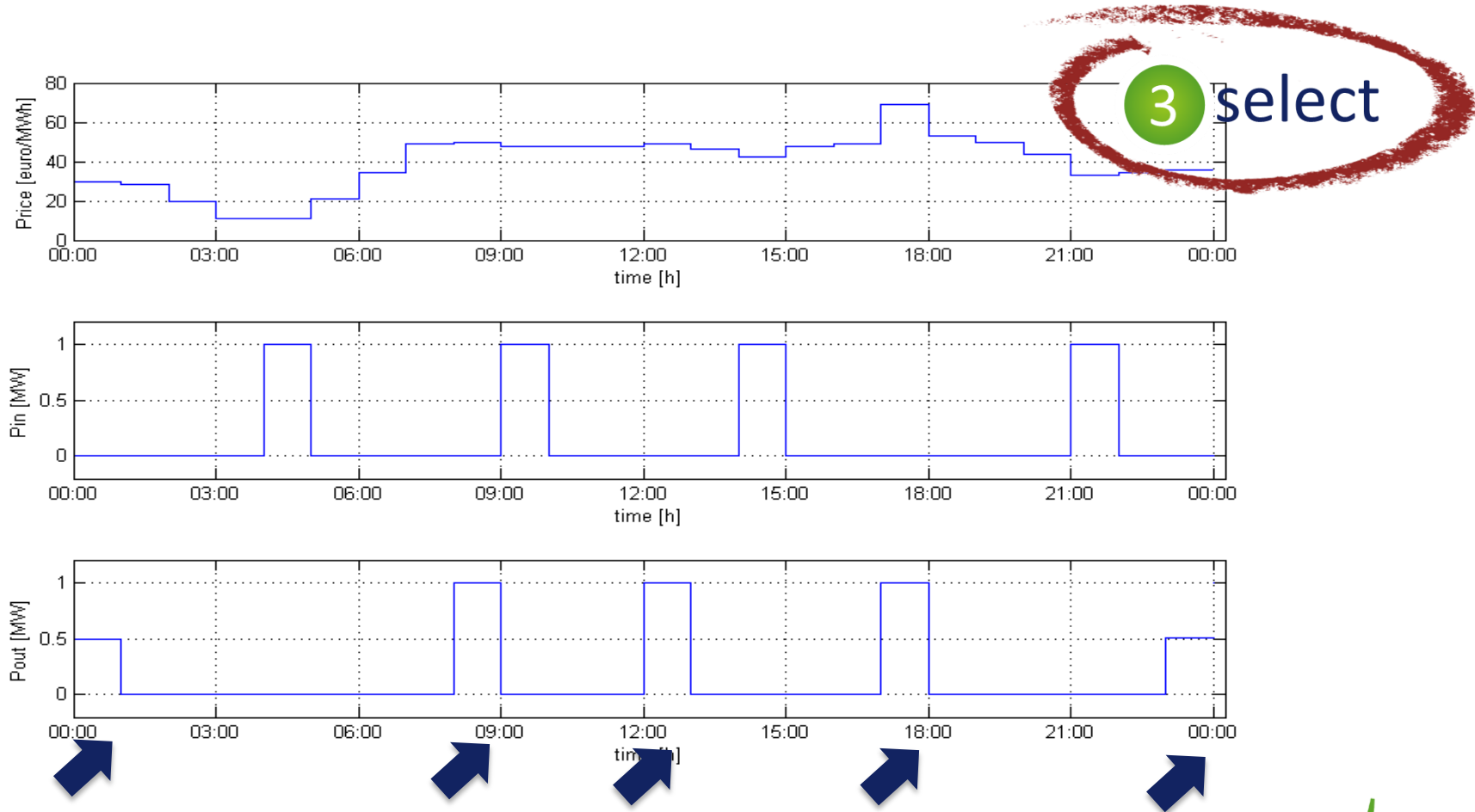
Making money with a “reference battery” on the day ahead market



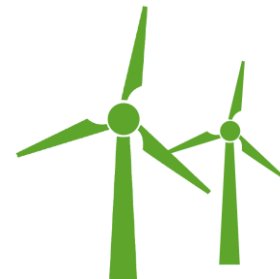
“Buy electricity when cheap ...”



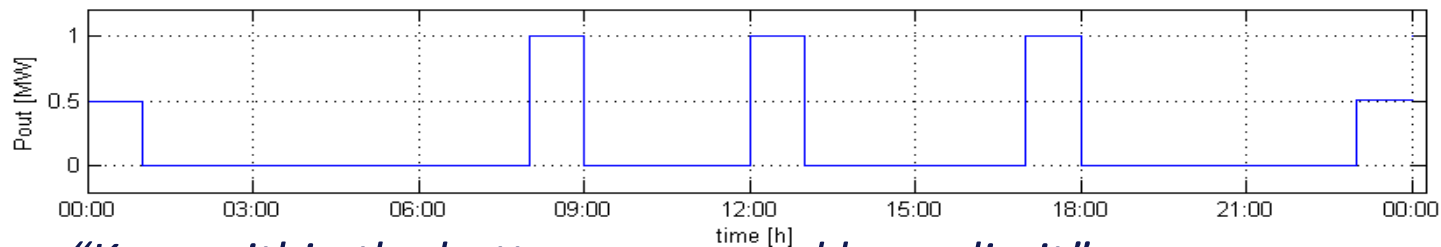
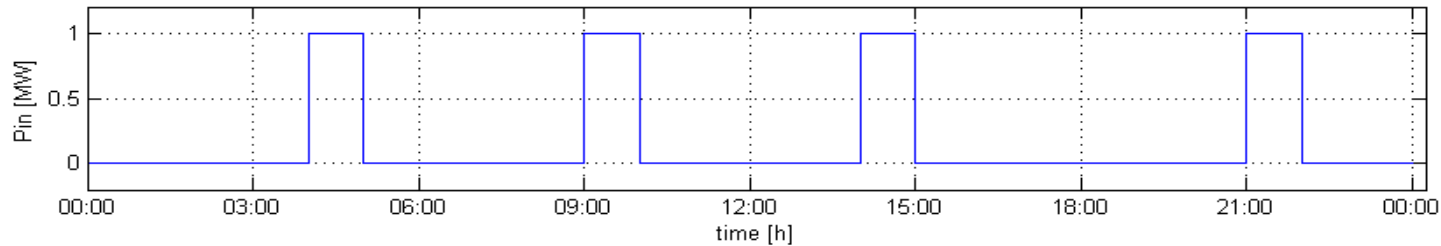
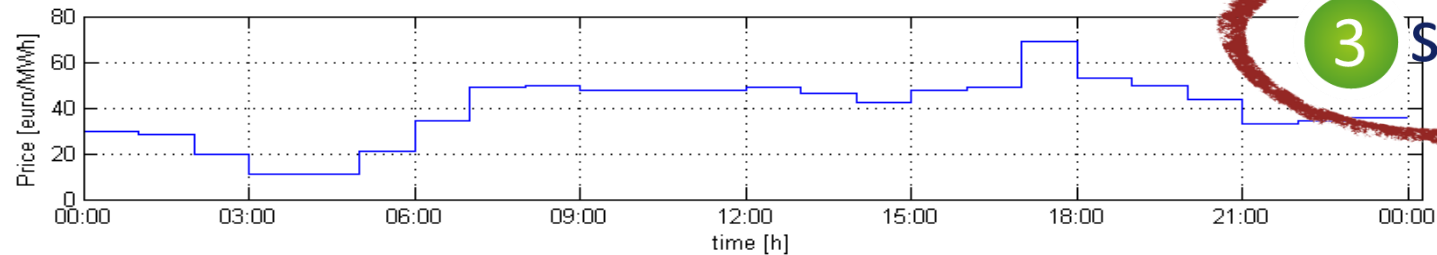
Making money with a “reference battery” on the day ahead market



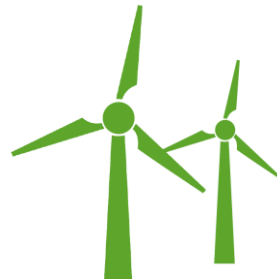
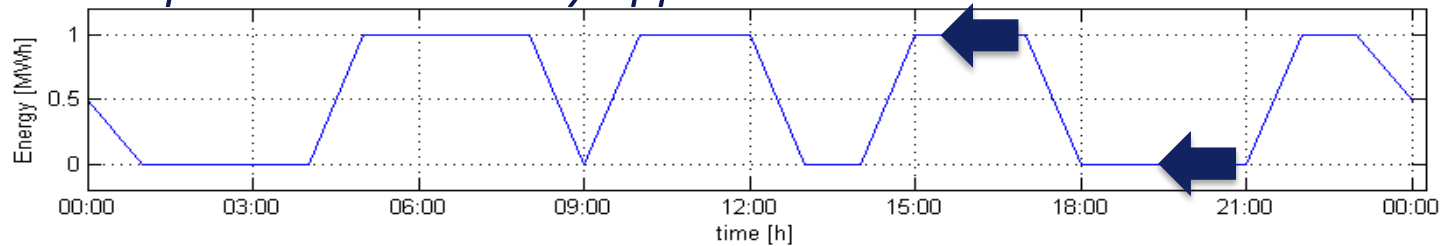
“We'll electricity when expensive ...”



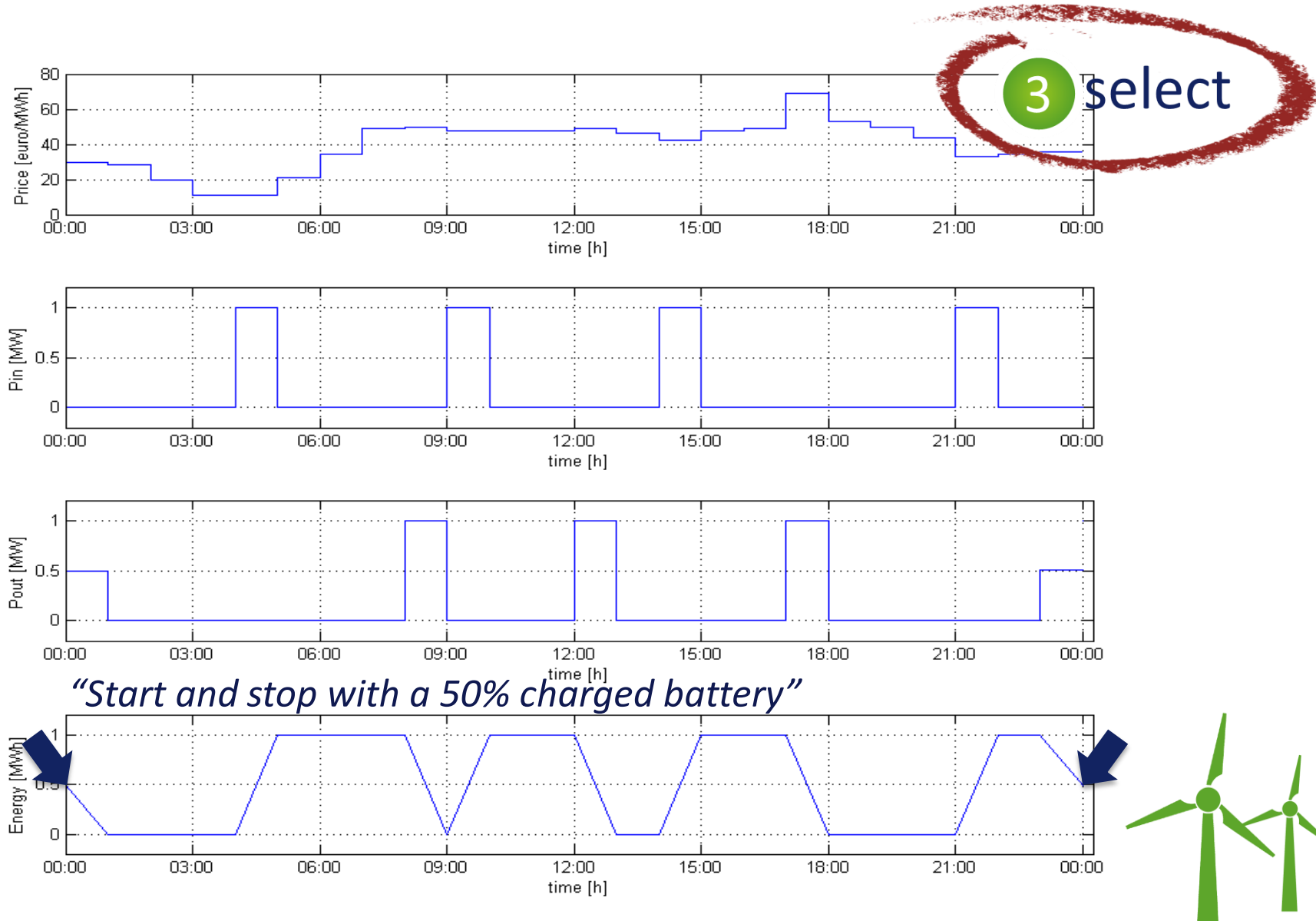
Making money with a “reference battery” on the day ahead market



“Keep within the battery upper and lower limit”



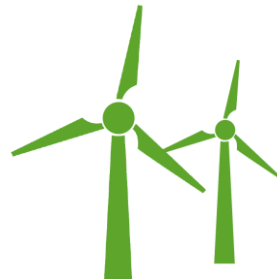
Making money with a “reference battery” on the day ahead market



3 select

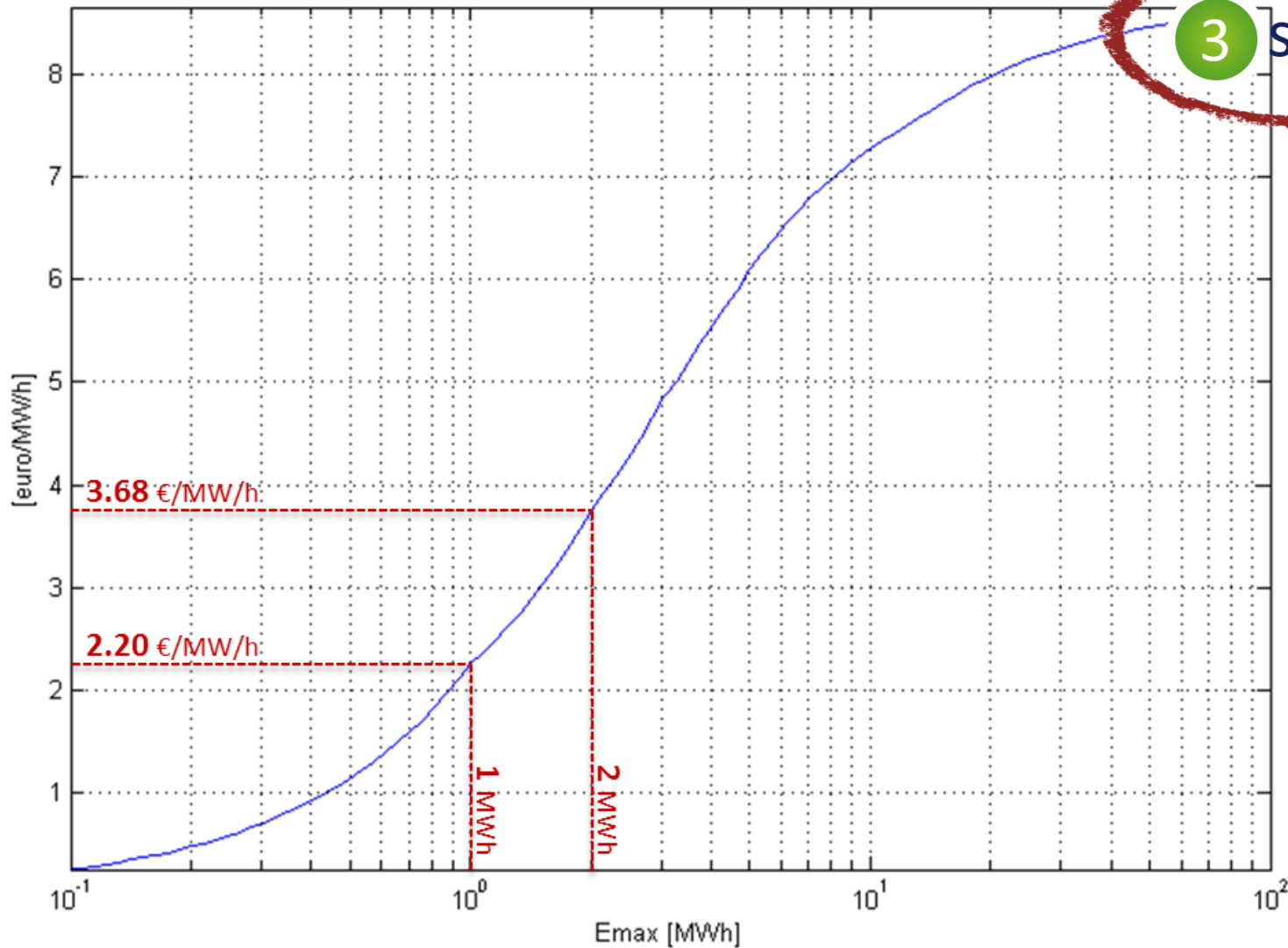
- For 1 day in this example: profit = 66,16€
- For whole year: profit = 19.240€/year
- ... or an average profit of **2,2€/MW/h**
- In case you double the battery size, but not the P_{in} and P_{out} , unfortunately this doesn't scale very well

“But why not putting it in a graph?”

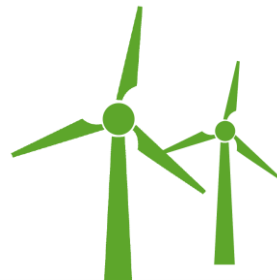


Part III: The simplified methodology step-by-step

The normalized business case graph

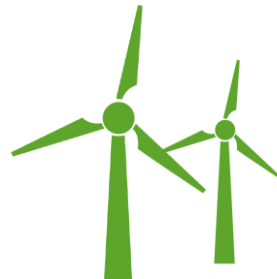


3 select



A smarter approach ... in 4 steps

- 1 map
- 2 normalize
- 3 select
- 4 scale**



1x



20x

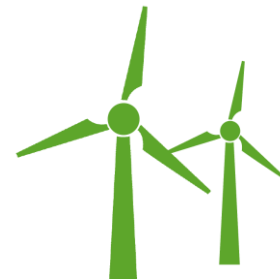


*“If you can earn **20€/year** by trading electricity on the day-ahead market with **1 car battery** ... “*

*$P_{in} = 2 \text{ kW}$
 $P_{out} = 2 \text{ kW}$
 $E_{max} = 1 \text{ kWh}$*

*“... you can earn **400€/year** with **20 car batteries!**“*

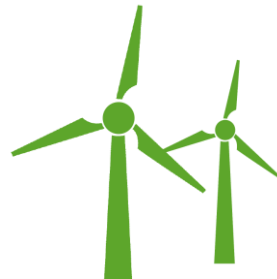
*$P_{in} = 40 \text{ kW}$
 $P_{out} = 40 \text{ kW}$
 $E_{max} = 20 \text{ kWh}$*



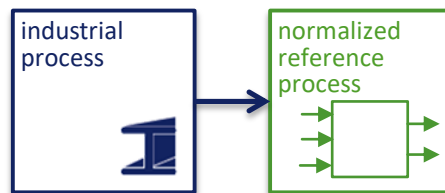
Summary



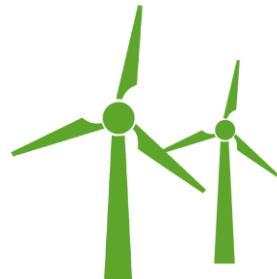
“Starting point is an industrial process ...”



Summary

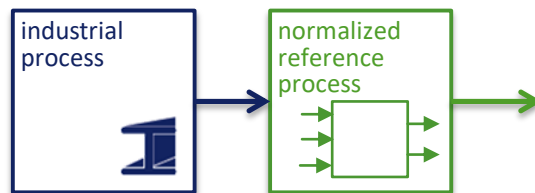


“ ... which will be mapped on a reference process ... ”

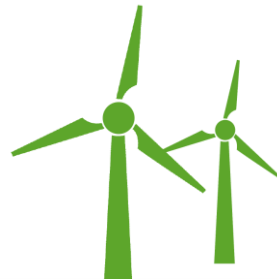


Summary

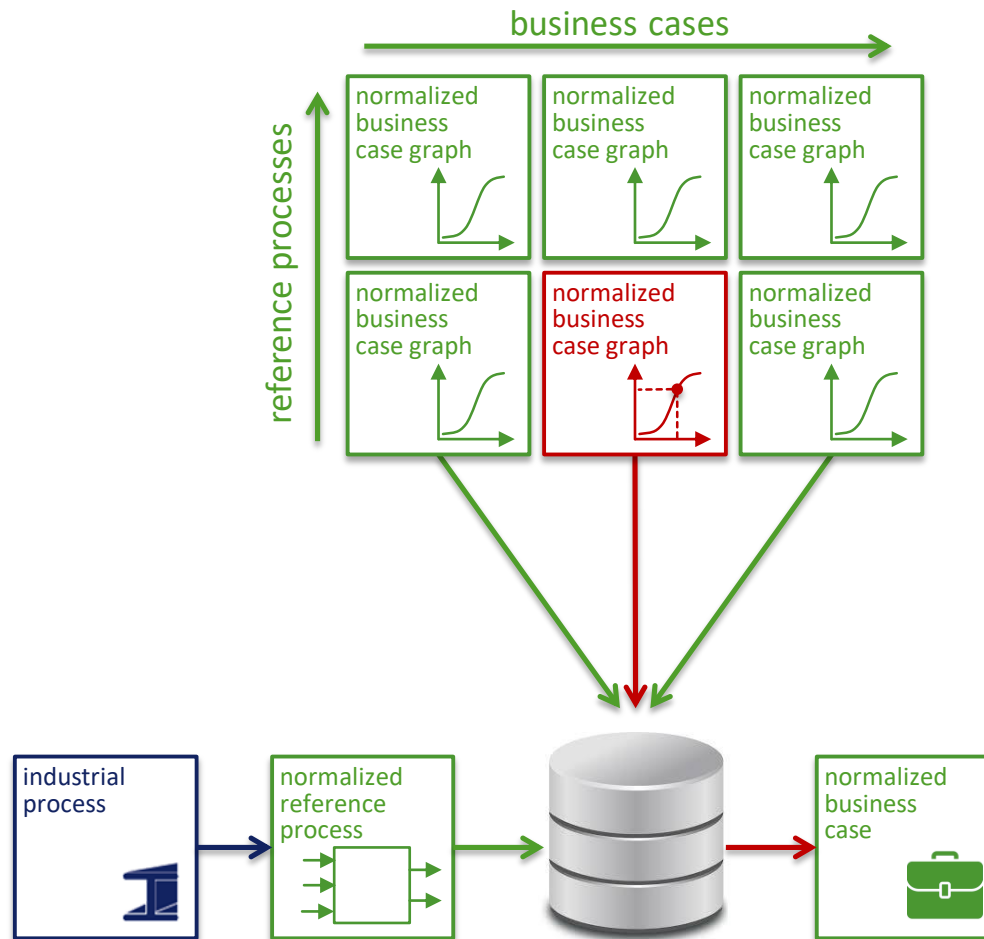
2 normalize



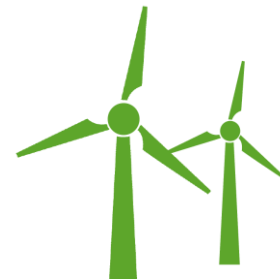
“ ... which is normalized to an 1MW equivalent ... ”



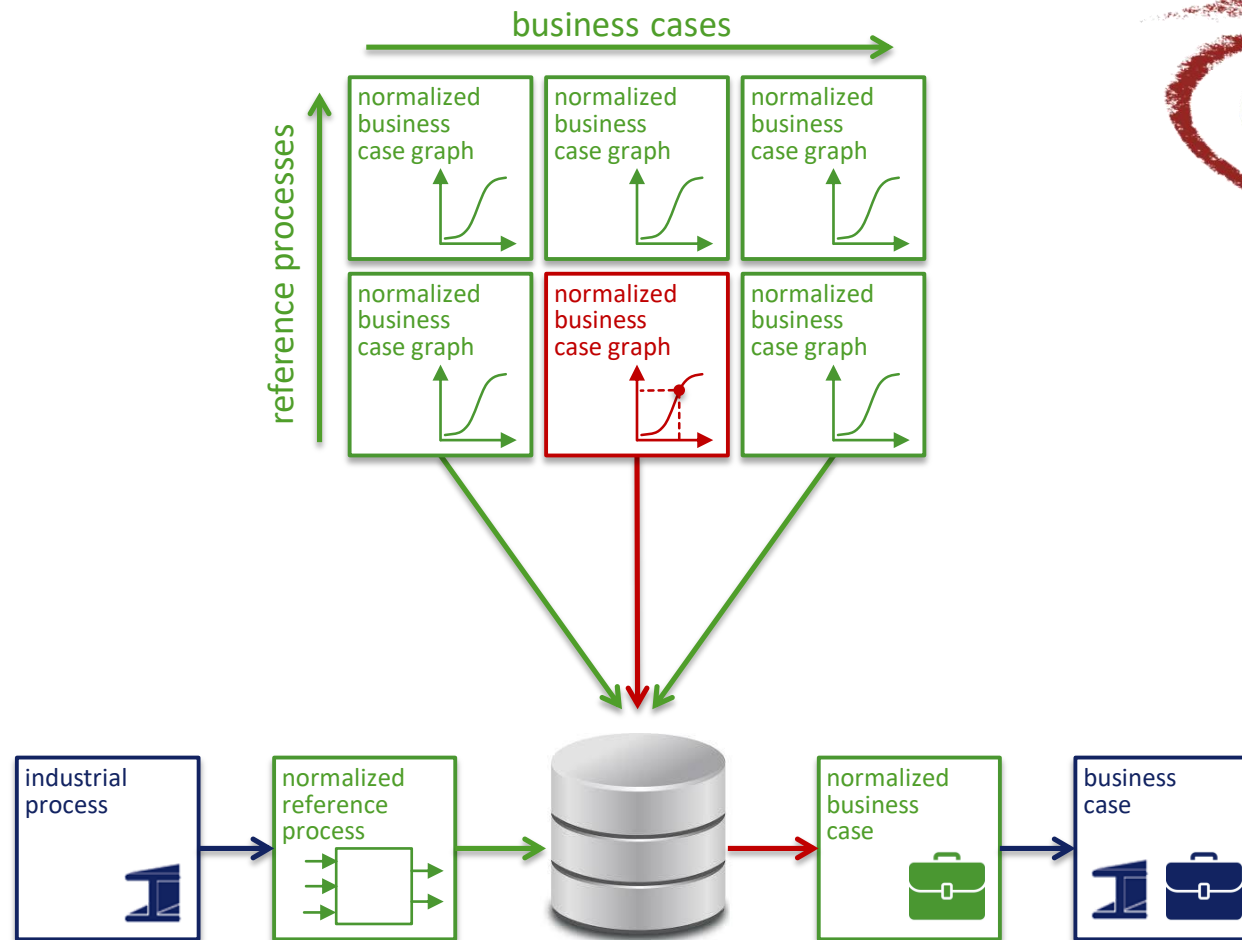
Summary



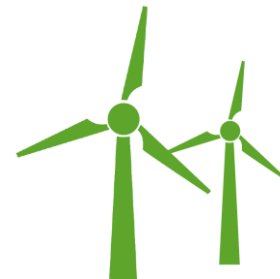
“ ... select the correct normalized business case graph and value ... ”



Summary

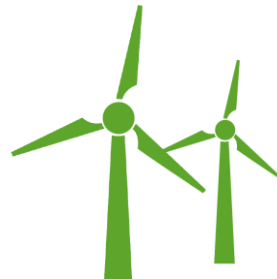


“ ... and scale back to the correct business case value.”

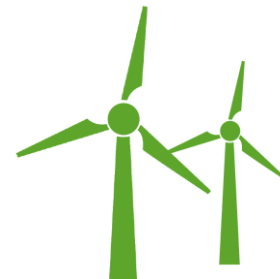
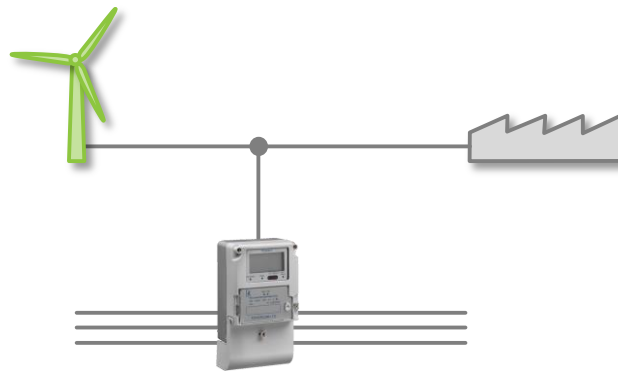


Contents

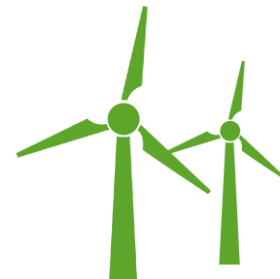
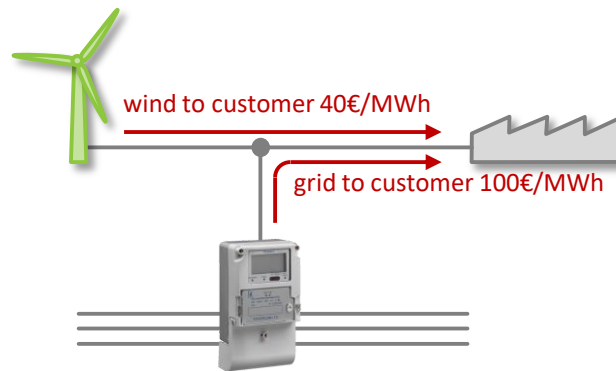
- Part I How calculating a demand response business case?
- Part II The need for a simplified methodology
- Part III The simplified methodology step-by-step
- Part IV On-site renewable energy business case
- Part V Conclusions and further steps



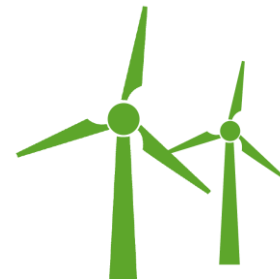
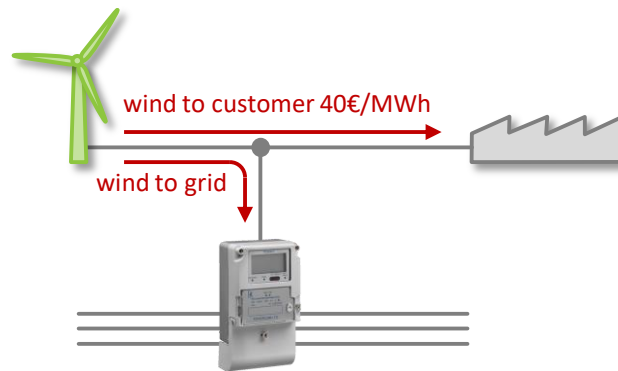
Configuration



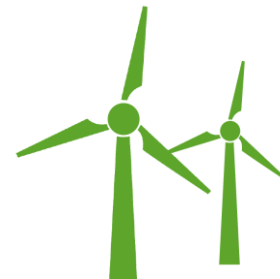
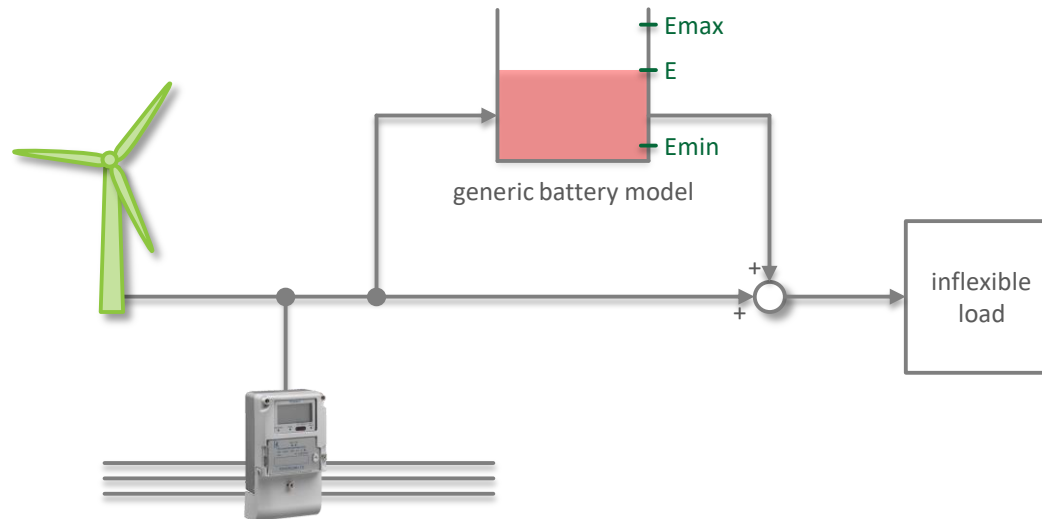
At low wind conditions



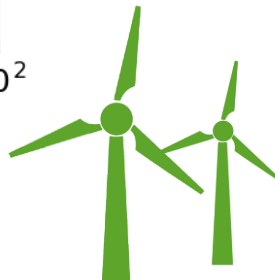
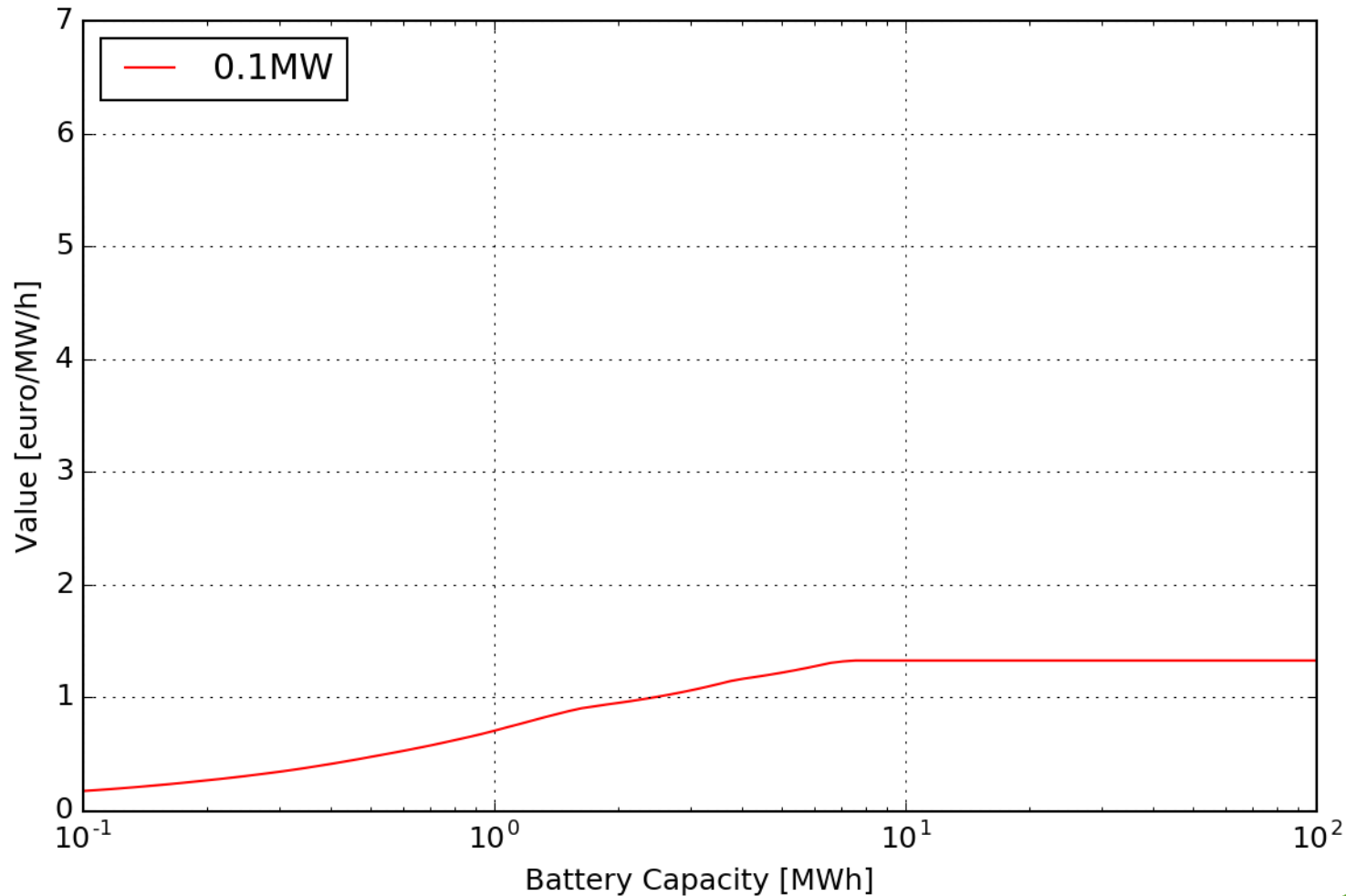
At high wind conditions



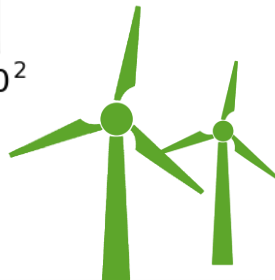
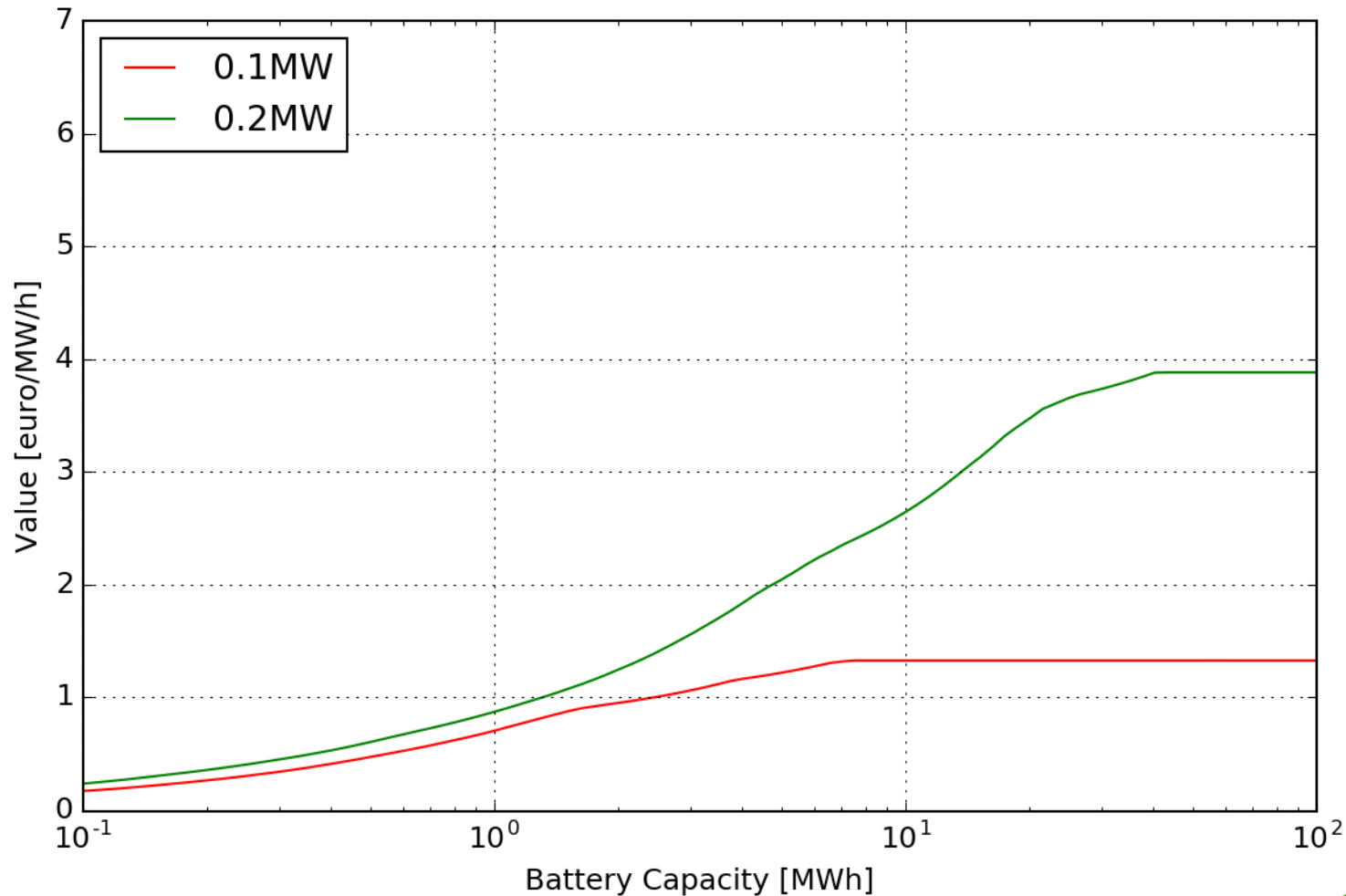
On-site VRE with the generic battery model



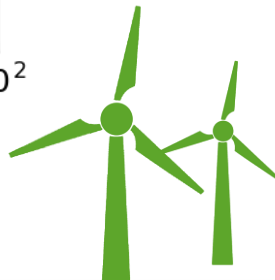
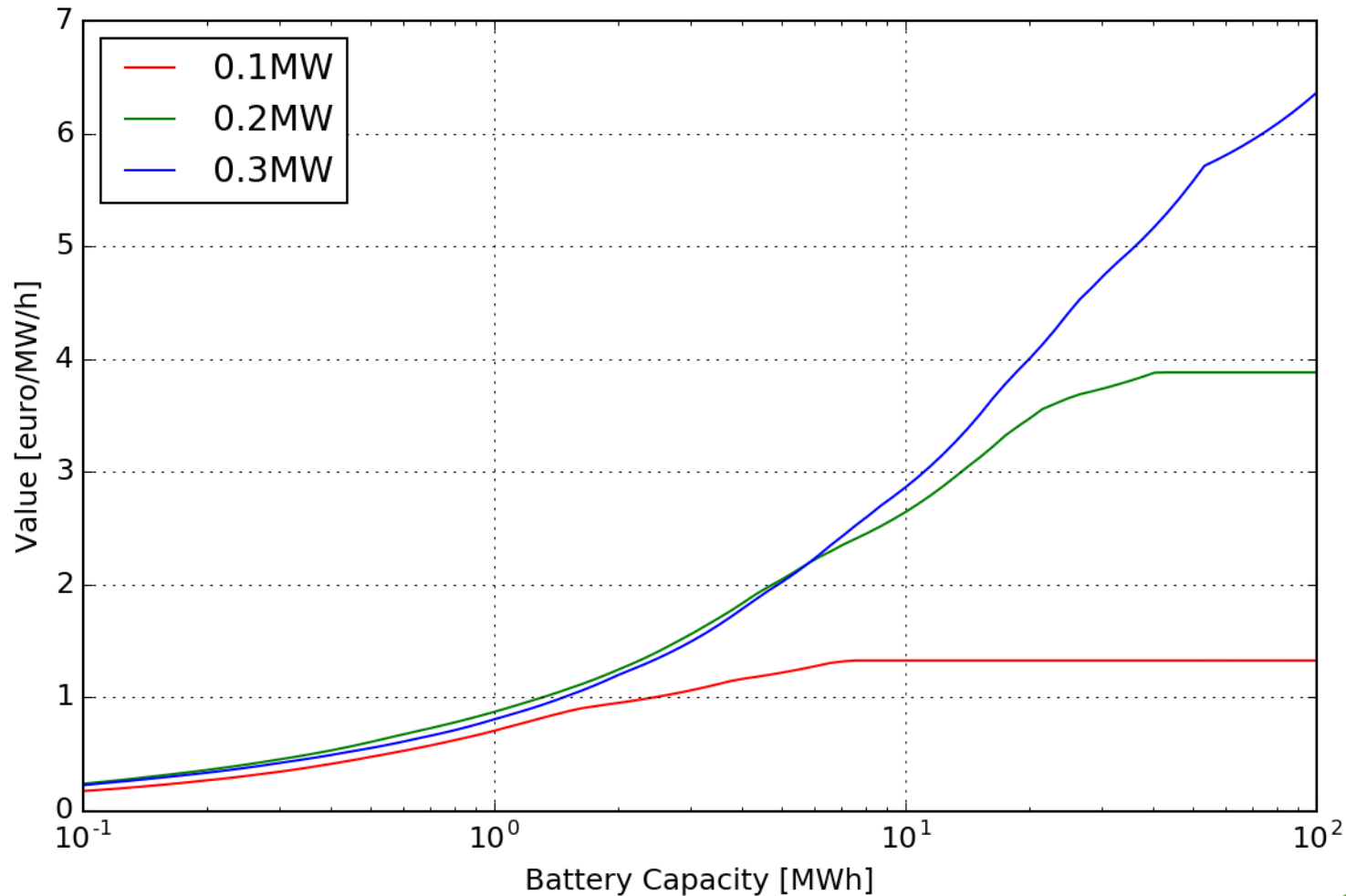
On-site VRE normalized business case graph



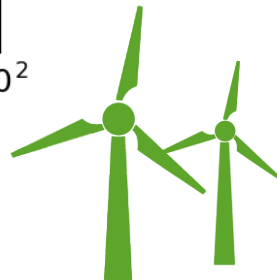
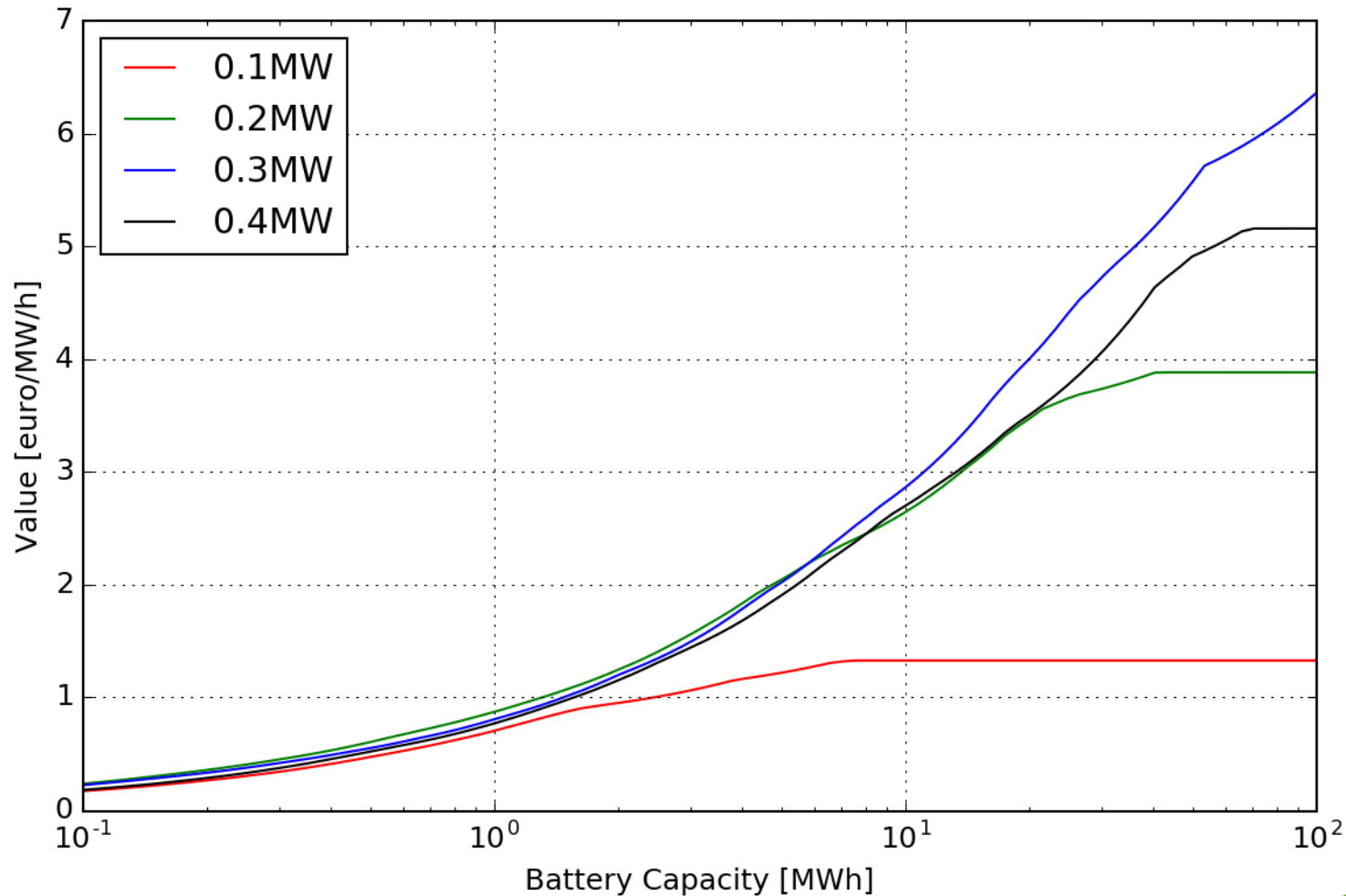
On-site VRE normalized business case graph



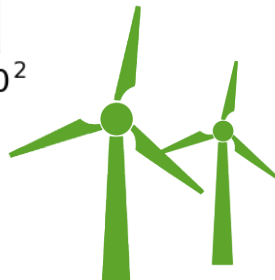
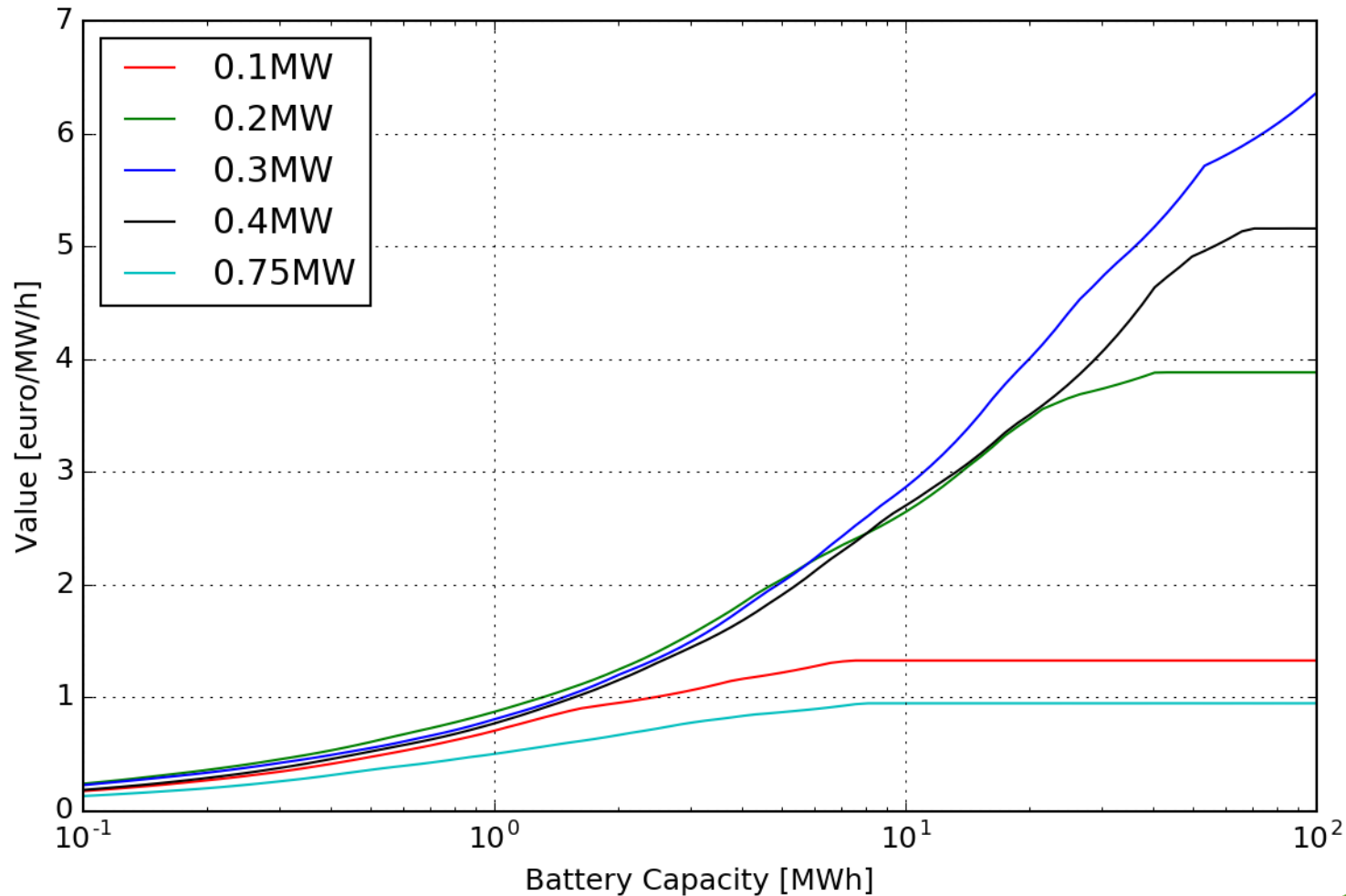
On-site VRE normalized business case graph



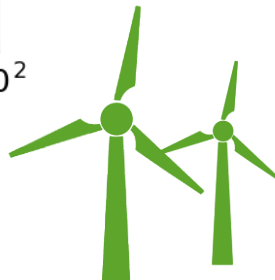
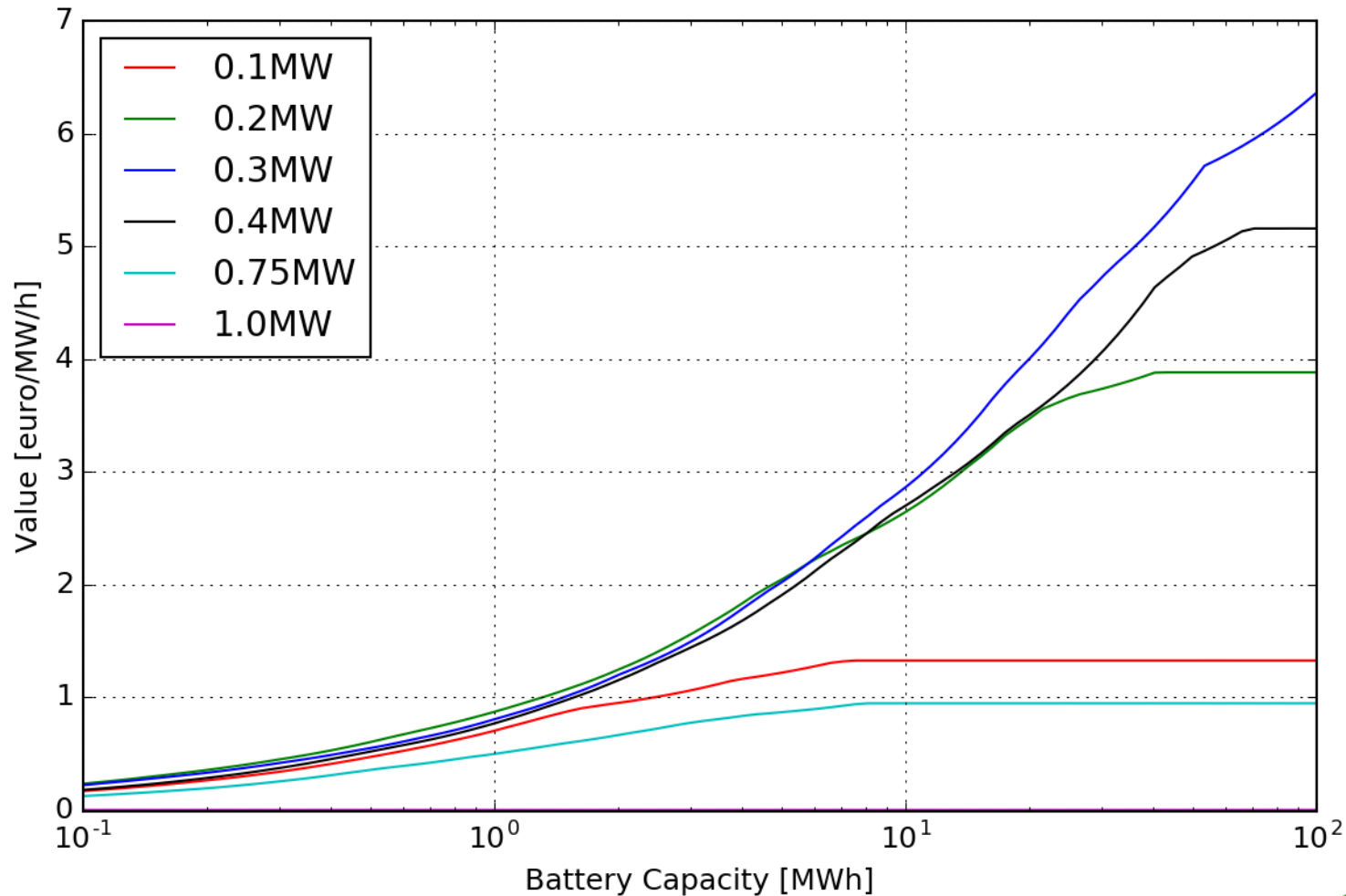
On-site VRE normalized business case graph



On-site VRE normalized business case graph

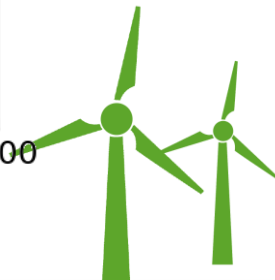
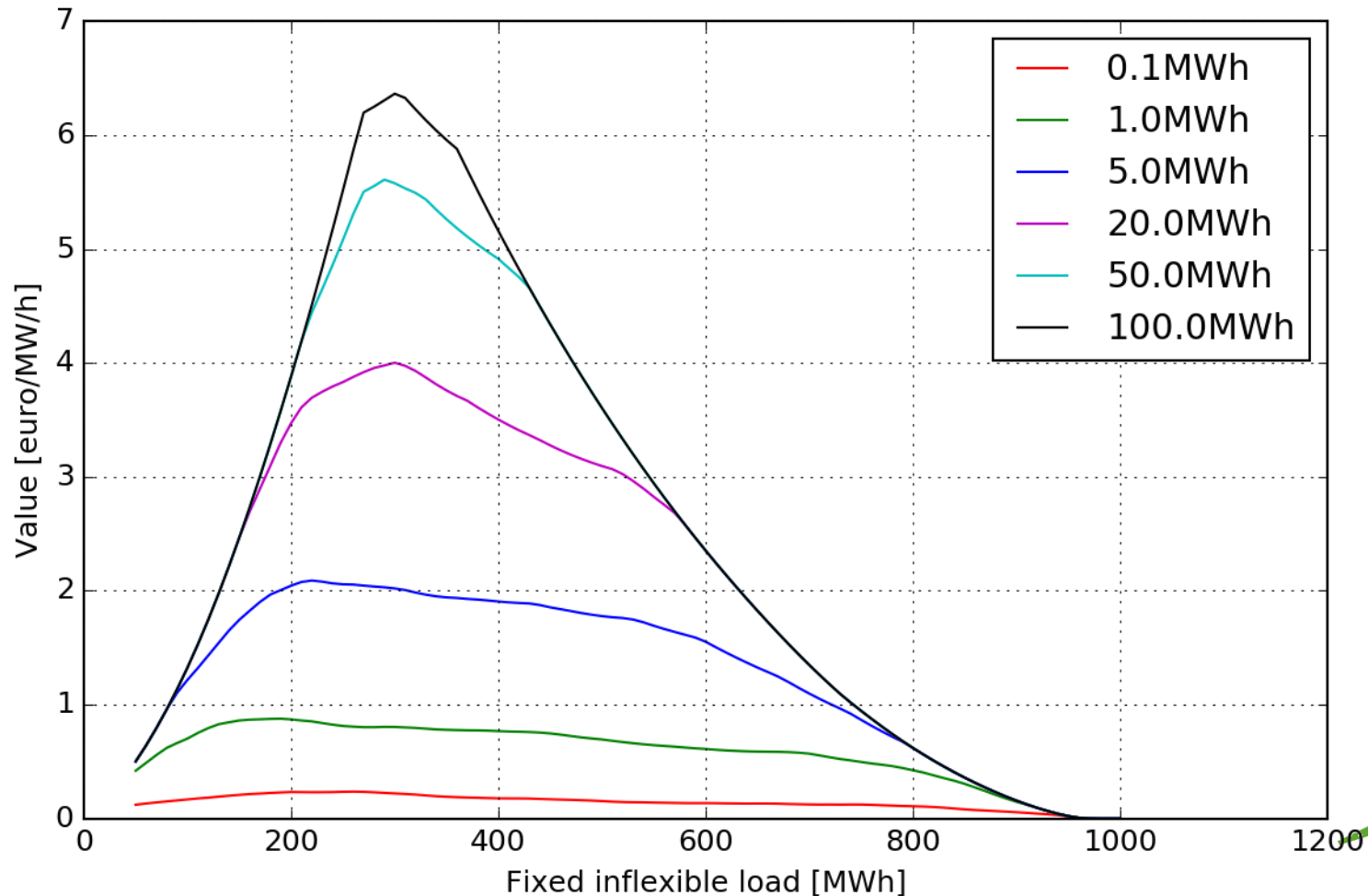


On-site VRE normalized business case graph



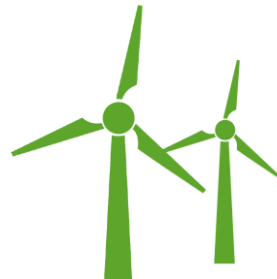
On-site VRE normalized business case graph

“ ... and if you plot it differently,
you even see that there are optimal ratio's ...”



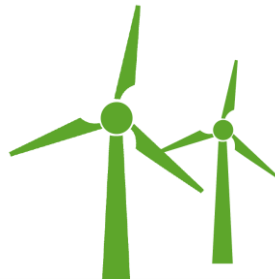
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- Part I How calculating a demand response business case?
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Have the requirements been met?

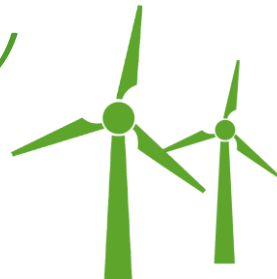
- 1 Being cost effective and time efficient
- 2 Order of magnitude accuracy estimation is good enough
- 3 No specific modelling and optimization knowledge and tools needed



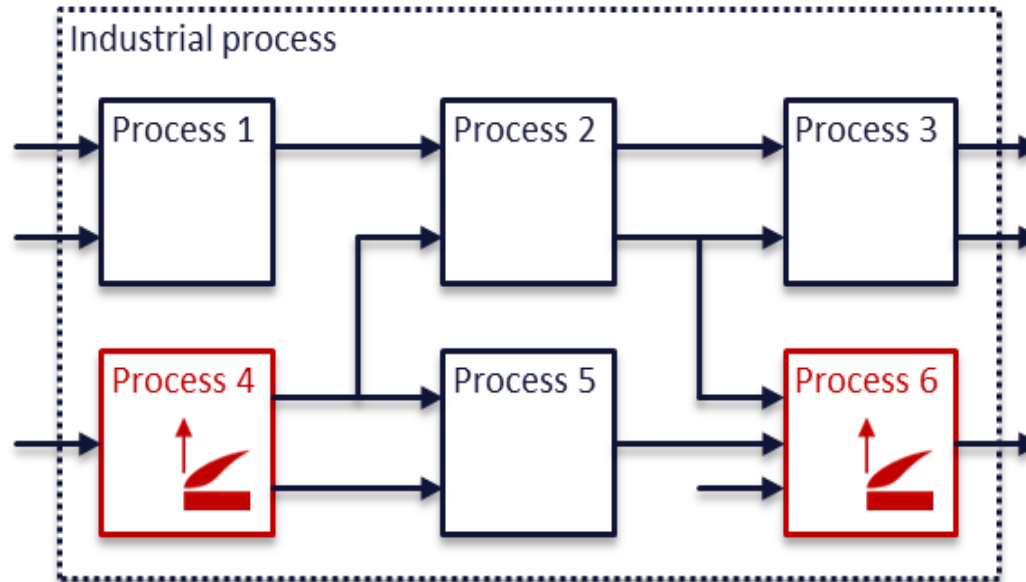
Have the requirements been met?

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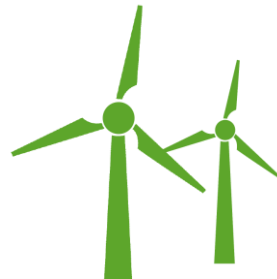
“ Under the condition that the industrial process can be mapped on a relevant reference process, the approach is very straightforward “



Does this really work for complex cases?

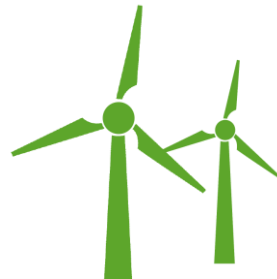


$$\text{BC value} \leq \text{BC4 value} + \text{BC6 value}$$



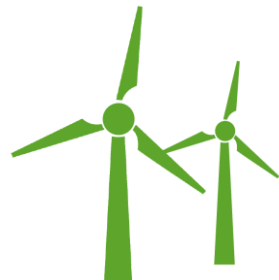
Next steps with the methodology

- 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



Next steps with the methodology

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



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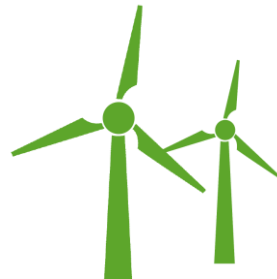
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