Online-Survey Results (WP2 & WP3)

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- Introduction
- Survey: Procedure & Completion
- Sample: Sociodemography & Energy Consumption
- Results
- Conclusion
Introduction

Aim

Prosumer and consumer perspectives on different distributed energy system business models

» With a large sample size
» In different European countries

Procedure

Online-Survey

Conducted between January and March 2019

Recruitment via:

» AAP subject database (approx. 2000 subjects)
» NEMoGrid website
» Press release university website TUC
» Flyer in university buildings
» Newsletter Sonnen GmbH
Procedure

Survey Structure

Demographics
Current energy consumption
Business as usual and
  » DSO controlled or...
  » Voltage-Tariff or...
  » Peer-2-Peer Tariff

Personality
Remuneration
Procedure

DSO, Volt or P2P were selected randomly for each respondent (each participant evaluated two models BaU and X)

Remuneration: Raffle 5 x 20€ transferred either via international bank transfer or PayPal

Survey duration: approx. 40min
Sample

Sociodemography

156 (88%) men & 22 (12%) women
49 years (SD = 12)
113 (64%) prosumer &
65 (36%) consumer

88% from Germany and...
Netherlands, Romania, Latvia, Finland, Denmark,
Austria, Belgium, Italy, Russia, Sweden,
Switzerland, United Kingdom
Sample

Sociodemography

Monthly Income

- Less than 1.500€: 4%
- 1.500€-3.000€: 19%
- 3.000€-4.500€: 25%
- 4.500€-6.00€: 25%
- More than 6.00€: 27%

City size

- Less than 5.000: 28%
- 5.000-20.000: 23%
- 20.000-50.000: 12%
- 50.000-100.000: 18%
- 100.000-500.000: 3%
- 500.00-1.000.000: 10%
- More than 1.000.000: 6%
Sample

Current Energy Consumption

57% Loads not controlled.
20% Loads controlled.
23% I don’t know.

Sample

Current Energy Consumption

53% have a contract with the largest possible share of electricity from renewable sources.
34% have a conventional contract with a typical grid mix.
3% don’t know.
Sample

Current Energy Consumption

Subjects have been using their (energy-)contract for 6 years on average ($SD=9.8$)

66% of the consumers thought about becoming a prosumer in the near future

Sample

Current Energy Consumption

The majority (67%) of prosumers recently (within the last 3 years) started to own their energy plant.

Since when do you own your energy plant? (n=113)
**Sample**

**Current Energy Consumption**

What have been/would be reasons for you to switch to self-production of electricity? Please award in total 100 point to the reasons listed below.

- To be independent of electricity companies
- To save money
- Contribute to climate protection
- Interest and curiosity about the new technology
- Revaluating my (real) estate
- Other

![Bar Chart showing mean distributed points]

- **Consumer**
- **Prosumer**

Mean Distributed Points
Sample Conclusion

The typical respondent of our survey...

- wants to contribute to climate protection
- is a prosumer since two years
- lives in a small city
- is male, German, 50 years old
- wants to save 40% of his monthly energy bill by participating in a future model
- did not receive subsidies
- thinks he is well informed about renewable energies
- is concerned that we will run out of fossil fuels
CONTENT

- Introduction
- Survey: Procedure & Completion
- Sample: Sociodemography & Energy Consumption
- Results
- Conclusion
Results

Perfect Energy Business Model

Open-Ended Question: What characterizes a future energy business model that is perfect for you?

» $n = 116$ (66%) respondents made 255 single statements

» Bottom-up built category system consisted of 13 different categories

» Intercoder-reliability: $\alpha = .86$ ("almost perfect agreement"; Fleiss & Levin, 2013)
What characterizes a future energy business model that is perfect for you?

- "Green": Sustainability, Renewability, Climate protection
- Secure, Stable and Reliable Supply
- Ease of use: Low Temporal and Cognitive Effort
- Availability and Comprehensibility of Information
- Applying Control over: Energy Consumption, Algorithm
- Privacy Preserving and Data Security Assured
- Affordable: Savings of Money and Energy, Reward System
- Efficient, Effective, Automated Grid
- Decentralised: Independence of and Autonomy from Big Companies
- Developable: Flexibility to Adjust to Personal Behavior or New Technologies
- Compatible with Other Technologies (E-Mobility) or Apps
- Social: Fosters Society and Public Welfare, Meets Ethical Standards
- Miscellaneous

The perfect energy business model should be affordable (20% of answers), green (14%) and decentralized (13%).
Acceptance
Ease of Use
Usefulness
Willingness to Use
Results

Acceptance

The majority of respondents are in favor of the future business model presented to them.

Overall, 67% of all respondents like to have the future business model for their billing.
Results

Acceptance

How do you evaluate the business model presented to you?

Future Business Models were not rated more useful than BaU. \( Z(178) = -0.123, p = .45 \)

BaU is more satisfying to users than future business models. \( Z(178) = -1.98, p = .02 \)
Results

Acceptance

How do you evaluate the business model presented to you?

Con- and prosumers do not differ in their evaluations of energy business models:

Usefulness scale
\( U = 3795.50, z = .37, p = .70 \)

Satisfying scale
\( U = 4028.50, z = 1.08, p = .28 \)
Results

Acceptance

How do you evaluate the business model presented to you?

Con-and prosumer do not differ in their evaluations of future energy business models:

Usefulness scale
- DSO: $U = 346.00, z = -0.70, p = .48$
- Volt: $U = 497.00, z = .24, p = .81$
- P2P: $U = 367.50, z = .95, p = .34$

Satisfying scale
- DSO: $U = 393.00, z = .05, p = .95$
- Volt: $U = 478.00, z = -.02, p = .97$
- P2P: $U = 390.00, z = 1.36, p = .17$
Perceived Usefulness

Picture: https://www.pexels.com/photo/silver-kinve-fork-6205/
Results

Perceived Usefulness

How do you evaluate the usefulness of the presented business model. Please indicate your level of agreement from 1 to 7 (3-item-scale).

Score BaU: \( M = 4.47 \ (SD = 1.62, \ N = 178) \)
Score future model: \( M = 5.25 \ (SD = 1.39, \ N = 178) \)

\[ t(177) = -5.363, \ p = .00^*, \ d = 0.51 \]

Respondents rate the perceived usefulness of future business models significantly higher than the current business model.
Results

Perceived Usefulness

Business as Usual $M= 4.47 \ (SD= 1.62, \ N= 178)$

- Consumer $M= 4.00 \ (SD= 1.66, \ Mdn= 3.67, \ N= 65)$
- Prosumer $M= 4.74 \ (SD= 1.55, \ Mdn= 5.00, \ N= 113)$

$U= 2668.50, \ z= -3.04, \ p= .00, \ d= 0.46$

Prosumers rate the future business models more positive than consumers.
Results

Perceived Usefulness

Future Energy Business Models:

- Consumer
  \( M = 5.36 \ (SD = 1.29, \ N = 65) \)
- Prosumer
  \( M = 5.18 \ (SD = 1.45, \ N = 113) \)

\[ U = 3440, \ z = -0.70, \ p = .48^*, \ d = 0.105 \]

Prosumers and consumers do not differ in their evaluation of usefulness of future energy business models.
### Results

#### Perceived Usefulness

<table>
<thead>
<tr>
<th>Future Energy Business Models:</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>• DSO</td>
<td>( M = 5.43 ) (( SD = 1.37 ), ( Md = 5.67 ))</td>
</tr>
<tr>
<td>• Volt</td>
<td>( M = 5.27 ) (( SD = 1.46 ), ( Md = 5.67 ))</td>
</tr>
<tr>
<td>• P2P</td>
<td>( M = 5.04 ) (( SD = 1.32 ), ( Md = 5.33 ))</td>
</tr>
</tbody>
</table>

\( H(2) = 2.91, \ p = .23 \)

We found no statistically significant difference between the perceived usefulness of future business models.
Results

Perceived Usefulness

Con- and prosumers do not differ in their evaluation of usefulness for the future models.
Perceived Ease of Use

Results

Perceived Ease of Use

How do you perceive the ease of use of the presented model? Please indicate your level of agreement from 1 to 7 (3-item-scale).

Score BaU: $M = 5.59$ ($SD = 1.11, N = 178$)
Score future model: $M = 4.14$ ($SD = 1.73, N = 178$)

$\Rightarrow t(177) = 10.366, p = .00^*, d = -0.96$

Respondents perceive the Ease of Use of future business models significantly lower than the current business model.
Results

Perceived Ease of Use

Future Energy Business Models: $M = 4.14$ ($SD = 1.73$, $N = 178$)

- Prosumer $M = 4.33$ ($SD = 1.73$, $N = 113$)
- Consumer $M = 3.82$ ($SD = 1.71$, $N = 65$)

$U(177) = 4299$, $z = 1.89$, $p = .06^*$, $d = 0.28$

Overall, prosumers rate the Ease of Use slightly better than consumers.
Results

Perceived Ease of Use

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Strongly agree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSO planned</td>
<td>5.5 (±0.3)</td>
<td>1.2 (±0.3)</td>
</tr>
<tr>
<td>Volt</td>
<td>3.8 (±0.2)</td>
<td>1.5 (±0.2)</td>
</tr>
<tr>
<td>P2P</td>
<td>4.0 (±0.2)</td>
<td>1.7 (±0.2)</td>
</tr>
</tbody>
</table>

*prosumer with pattern*
Results

Perceived Ease of Use

Future Energy Business Models: 

- **DSO** \( M = 4.91 \) (\( SD = 1.36, \) \( Md = 5.00 \)) 113.81
- **Volt** \( M = 3.55 \) (\( SD = 1.73, \) \( Md = 3.33 \)) 72.20
- **P2P** \( M = 4.14 \) (\( SD = 1.78, \) \( Md = 4.00 \)) 83.15

\[ H(2) = 21.07, \ p = .00, \ d = 0.69 \]

Ease of Use for future energy business models differs significantly: highest for the DSO planned, followed by P2P, neutral for the Voltage tariff.
Willingness to Use
Results

Willingness to Use

How willing are you to use the presented business model? Please indicate your level of agreement from 1 to 7.

Future Energy Business Models: $M=4.72$ ($SD=1.91$, $N=178$)

- Consumer $M = 4.72$ ($SD=1.89$, $Md=5.33$, $N=65$) 88.93
- Prosumer $M = 4.72$ ($SD=1.93$, $Md=5.00$, $N=113$) 89.83

$U= 3635$, $z= -.11$, $p= .91^*$

Willingness to Use equally high for both user groups.
## Results

### Willingness to Use

Future Energy Business Models:

<table>
<thead>
<tr>
<th>Model</th>
<th>Mean ($M$)</th>
<th>Standard Deviation ($SD$)</th>
<th>Median ($Md$)</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSO</td>
<td>4.76</td>
<td>1.89</td>
<td>5.00</td>
<td>90.22</td>
</tr>
<tr>
<td>Volt</td>
<td>4.69</td>
<td>1.99</td>
<td>5.33</td>
<td>89.80</td>
</tr>
<tr>
<td>P2P</td>
<td>4.70</td>
<td>1.87</td>
<td>5.00</td>
<td>88.43</td>
</tr>
</tbody>
</table>

$\rightarrow H(2) = 0.03, \ p = .98$

The Willingness to Use for different future energy business models does not differ significantly.
Results

Willingness to Use

There was no clear statistically significant difference in the Willingness to Use different energy models and users.
Acceptance

(satisfying)

Ease of Use

Usefulness

Willingness to Use

n. a.
Summary

The interviewees find the currently used business model more acceptable than the future ones. There is no difference in evaluation between the future models. From this it can be concluded that the respondents are open-minded and interested in new models.

New business models, no matter which one, are evaluated in any case more useful than the current model.

The simplicity of use can be best evaluated in the current model, so particularly positive ratings are not surprising here. We see, however, that prosumers rate future business models more positively than consumers. One reason for this may be the role of the prosumer as being highly interested in new technologies in general.

Pictures:
Summary

The DSO model is rated most positively. We could not find any differences between the user groups in the current survey.

In a previous study with a smaller sample size, we saw that prosumers preferred the P2P and consumers preferred DSO model. With regard to the current results it seems that user groups will have no influence in the future.

We could not find any influences of the user groups or the business models on the prediction of the willingness to use either of these models.

Pictures:
Expectancy
Results

Expectancy

We used the information gained in the in-depth interviews with pro- and consumers to formulate expectations towards the new business models.

Positive statements (expectations) & negative statements (fears) were presented.

Agreements on the statements between future business models were compared.
**Results**

I promote the integration of renewables into the grid.
that I contribute to the grid stabilization (by the usage of this model).
I perceive the model as modern and up-to-date.
I can save money.
I don’t have to do much by myself.
I become curious about the model.
the stable functioning.
other institutions and not me should take care of the grid.
my individual influence is limited.
I have less effort (in this model), because somebody else takes care of the maintainance.
I feel a social obligation to participate.
I become dependent on other actors.
I have (a) direct influence.
I do not know what to expect in terms of costs.
data protection is not ensured.
I have to overcome hurdles such as the installation of infrastructure and bureaucracy.
I have to restrict my own consumption habits.
it (the model) does not fit to my consumption habits.
I can hardly understand it.

When I use this model I have the expectation...

- DSO
- Volt
- P2P
Results

People believe they can save money, contribute to the grid stabilization and integrate renewable energies.

We see some disagreement with some of the items.

The models are not rated that good, in terms of effort needed to invested and data protection.

We found significant differences between models for the items marked with “*”.

When I use this model I have the expectation...

<table>
<thead>
<tr>
<th>DSO</th>
<th>Volt</th>
<th>P2P</th>
</tr>
</thead>
</table>

* | | | |

* | | | |

* | | | |

* | | | |

* | | | |
Results

Expectancy

When I use this model I have the expectation that...

- I don`t have to do much by myself.
- I have (a) direct influence.
- I do not know what to expect in terms of costs.
- I have to overcome hurdles such as the installation of infrastructure and bureaucracy.

DSO controlled model is appreciated because of its reduced effort and comprehensibility. Personal influence is perceived highest for P2P.
## Results

### Expectancy

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Kruskal-Wallis Test</th>
<th>DSO vs. Volt</th>
<th>DSO vs. P2P</th>
<th>Volt vs. P2P</th>
<th>Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t have to do much by myself.</td>
<td>( H(2)=12.20, p=.002 )</td>
<td>(-3.36, p=.002)</td>
<td>(-2.49, p=.038)</td>
<td>-</td>
<td>DSO (71.57)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P2P (94.53)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volt (101.94)</td>
</tr>
<tr>
<td>I have a direct influence.</td>
<td>( H(2)=6.14, p=.046 )</td>
<td>-</td>
<td>2.44</td>
<td></td>
<td>P2P (79.22)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volt (87.39)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSO (101.65)</td>
</tr>
<tr>
<td>I can hardly understand it.</td>
<td>( H(2)=10.82, p=.004 )</td>
<td>2.95</td>
<td>2.73</td>
<td></td>
<td>P2P (51.56)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( p=.009 )</td>
<td>( p=.019 )</td>
<td></td>
<td>Volt (80.14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSO (107.01)</td>
</tr>
<tr>
<td>I have to overcome hurdles such as the installation of infrastructure and</td>
<td>( H(2)=15.10, p=.001 )</td>
<td>3.81</td>
<td>2.56</td>
<td></td>
<td>Volt (74.63)</td>
</tr>
<tr>
<td>bureaucracy.</td>
<td></td>
<td>( p=.001 )</td>
<td>( p=.031 )</td>
<td></td>
<td>P2P (85.45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSO (109.04)</td>
</tr>
<tr>
<td>I don’t know what to expect in terms of costs.</td>
<td>( H(2)=6.24, p=.044 )</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>P2P (80.31)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Volt (85.73)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>DSO (102.34)</td>
</tr>
</tbody>
</table>

DSO differs significantly in user perception.
## Results

### Expectancy

<table>
<thead>
<tr>
<th></th>
<th>$U$</th>
<th>$z$</th>
<th>$p$</th>
<th>Consumer ($N=65$)</th>
<th>Prosumer ($N=113$)</th>
<th>$\eta^2$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I don’t have to do much by myself.</td>
<td>2874.00</td>
<td>2.50</td>
<td>0.012</td>
<td>101.78 ($M=3.17$ ($SD=1.15$))</td>
<td>82.43 ($M=2.73$ ($SD=1.00$))</td>
<td>0.03</td>
<td>0.36</td>
</tr>
<tr>
<td>I have to overcome hurdles such as the installation of infrastructure and bureaucracy.</td>
<td>4398.50</td>
<td>318.17</td>
<td>0.023</td>
<td>78.33 ($M=2.45$ ($SD=1.17$))</td>
<td>95.92 ($M=2.77$ ($SD=0.98$))</td>
<td>0.027</td>
<td>0.333</td>
</tr>
<tr>
<td>I have to restrict my own consumption habits</td>
<td>4607.50</td>
<td>2.92</td>
<td>0.003</td>
<td>75.12 ($M=2.77$ ($SD=1.17$))</td>
<td>97.77 ($M=3.28$ ($SD=1.01$))</td>
<td>0.045</td>
<td>0.433</td>
</tr>
<tr>
<td>I don’t know what to expect in terms of costs.</td>
<td>4336.50</td>
<td>2.08</td>
<td>0.38</td>
<td>79.28 ($M=2.48$ ($SD=1.17$))</td>
<td>95.38 ($M=2.81$ ($SD=1.04$))</td>
<td>0.023</td>
<td>0.304</td>
</tr>
</tbody>
</table>

Consumers are more skeptical in terms of personal effort, bureaucratic barriers, behavioral changes and cost transparency.
Results

Summary Expectancy

Respondents expect to save money, contribute to grid stabilization and integrate renewable energies when they participate in future energy business models. However, the presented new business models are not rated “good” in terms of effort users need to invest and data protection concerns. Users criticize low transparency and high investment costs.

On the one hand installation effort is supposed to be very high for Voltage tariff and Peer-2-Peer (P2P). For P2P on the other hand users expect to have the highest influence. DSO brings significantly less bureaucratic hurdles and is significantly easier to understand.

Compared to prosumers, consumers are more concerned about the costs. Consumers think, they have a lot to do when using the business model and think that installation and bureaucracy hurdles are high. Further they feel more restricted than prosumers.

Picture: https://www.pexels.com/photo/dandelion-nature-sunlight-54300/
Design of Interaction Device for Peer-2-Peer Scenario

Picture: https://www.pexels.com/photo/group-hand-fist-bump-1068523/
Results

Design of Interaction Device

How motivating do you rate the following information?

How helpful are the following information/factors to motivate you to use energy more efficiently?

Indicate your motivation on a scale ranging from 1 = completely not motivating to 6 = completely motivating.

→ Design options extracted from literature research (WP 4.1) and input for focus groups WP 4.2 (only P2P of interest)

We separated data for this presentation in agreement and refusal.
Results

Design of Interaction Device (P2P; prosumers only)

- The average energy consumption frequently (e.g., per week)
- The change of my average energy consumption over time
- Information on the stability of the electricity grid
- Information on personal savings
- Information on the demand for balancing power
- The average energy consumption of the community (e.g., all other consumers in my district or house)
- A financial reward which I can receive as the most energy efficient consumer
- Information on personal earnings
- Information on critical network situations
- The comparison of my average energy consumption with that of the community (ranking energy-efficient consumers)
- Information about community (the people who live in the same area) savings
- Information on savings in comparison to other communities
- Information about earnings in comparison to other communities
- Information on savings in comparison to other consumers (anonymized)
- Information on savings in comparison to other prosumers (anonymized)
- Information about community (the people who live in the same area) earnings
- Information about earnings in comparison to other prosumers (anonymized)

Prosumer Agreement  Prosumer Refusal
Results

Design of Interaction Device (P2P; consumers only)

- The change of my average energy consumption over time.
- Information on personal savings.
- The comparison of my average energy consumption with that of the community (ranking most energy-efficient...)
- Information on the stability of the electricity grid.
- Information on the demand for balancing power.
- Information on critical network situations.
- Information about earnings in comparison to other prosumers (anonymized).
- The average energy consumption frequently (e.g., per week).
- A financial reward which I can receive as the most energy efficient consumer.
- Information on personal earnings.
- The average energy consumption of the community (e.g., all other consumers in my district or house).
- Information on savings in comparison to other consumers (anonymized).
- Information about community (the people who live in the same area) savings.
- Information on savings in comparison to other communities.
- Information about earnings in comparison to other communities.
- Information on savings in comparison to other prosumers (anonymized).
- Information about community (the people who live in the same area) earnings.

Consumer Agreement

Consumer Refusal
Results

Mode of Information for Peer-2-Peer

Email, smartphone app and web portal are desired user interfaces to receive information about P2P scenario.
Results

Mode of Information for Peer-2-Peer

Users prefer real-time information and weekly/monthly information summaries.
Results

Summary Design of Interaction Devices for Peer-2-Peer Scenario

Pro- and consumers first choice for gathering information about the business model P2P is by email, followed by smartphone, web application and digital interface.

The preferred information frequency is real-time and weekly followed by monthly and daily.

Most important information is the average energy consumption as well as the change of energy consumption over time, personal savings and financial rewards and earnings, the grid stability and required balancing power. At first sight it seems like prosumers are more interested in comparison (with the community).

Picture: https://www.pexels.com/photo/group-hand-fist-bump-1068523/
Final Comments

Open-ended question: Do you have any comments on the questionnaire?

- \( n = 59 \) (33\%) respondents made 72 single statements
- Bottom-up built category system contained 7 different categories
- Intercoder reliability: \( \alpha = .89 \) ("almost perfect agreement"; Fleiss & Levin, 2013)
Final Comments

Do you have any comments on the questionnaire?

- Positive Feedback
- Request of More Information
- Comprehensional Problems
- Structural Problems with Completing Answers
- Language Problems
- Questionnaire Independent Remark (miscellaneous)
- No Comments

Relative Frequency of Statements (%)
THANK YOU!

Contact us

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