



# Innovative large-scale energy storage technologies and Power-to-Gas concepts after optimisation

## D9.4

### Design and development of the 3-day training programme, including online learning programmes, case development and other information bases

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**Author(s)** Miralda van Schot, Lisette Poot - de Vries  
**Reviewer** Helge Föcker (Uniper), Simon Verleger (DVGW)  
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#### Dissemination level

- x** **PU** Public
- PP** Restricted to other programme participants (including the Commission Services)
- RE** Restricted to a group specified by the consortium (including the Commission Services)
- CO** Confidential, only for members of the consortium (including the Commission Services)

## Document history

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## Executive Summary

This report focuses on the development and design process of the training programme “Power to (the) molecules – from technology to market uptake”, which will be executed in a series of eight editions. The programme exist out of an online and classroom programme, which together will take the participant 3 days. During the online and classroom parts of the training programme different learning methods and materials will be used.

The first part of the report concerns the to be taken activities to come to the final programme, such as content development, lecturers’ selection, learning methods, material development, marketing and logistics. The second part of the report broadly explains the training requirements and objectives of “Power to (the) molecules – from technology to market uptake” as well as the first outcomes in the developmental process.

## 1 Introduction

The expertise developed in diverse fields of the STORE&GO project will be shared to (young) energy professionals and researchers, through a series of trainings on large-scale storage of energy modalities. The intention is that the training has an interdisciplinary character, and the content is strongly related to the testing and implementation activities in the industry. The participants to the programmes become informed about the various technical, economic, regulatory and social aspects that are relevant to this energy conversion/storage technology. As the project STORE&GO, the programme is set up to put the technology into the wider perspective of the energy system, and to analyse what constitutes its business case and long-term perspective in contributing a future sustainable and reliable energy system in Europe. The training programmes will be developed and organised by the Energy Delta Institute (EDI) in close cooperation with the experts within the extensive network of lecturers of EDI, and in conjunction with experts from the various consortium partners of this research project. Lecturers and trainers in the programmes will be both from the research community and the industry, on about equal basis.

This report focuses on the development and design process of the 3-day training programme “Power to (the) molecules – from technology to market uptake”, which will be executed in a series of eight editions. The to be taken activities to come to the final programme, such as content development, lecturers’ selection, learning methods, material development, marketing and logistics, are discussed in chapter 2. The training requirements and objectives of “Power to (the) molecules – from technology to market uptake” as well as the first outcomes in the developmental process are broadly explained in chapter 3.

## 2 Development process

To get to a qualitative training programme for (young) energy professionals and researchers, several steps have to be taken. The steps are related to the following issues: learning methods, content, lecturers, learning material, marketing and logistics. In this chapter the actions during the development process, which are already taken or are planned, are described.

### 2.1 Content

The road to a qualitative programme consists of incremental steps and continuous reflection. A concept programme is generally developed 6–10 months prior to the start of a programme. The concept of “Power to (the) molecules – from technology to market uptake” has been based on intensive desk research and multiple talks with expert in different fields of the project. These experts hold positions in the project/reference group consisting of consortium partners within the STORE&GO programme.

A second important step in the development of an open-market training programme is to secure of its relevance for the energy market. By analysing market development, direct contact with EDI partners as well as business talks during conferences (e.g. E-world) we made certain that an appropriate balance of topics in the programme “Power to (the) molecules – from technology to market uptake” is supported by the industry. The output from the project team combined with desk-research and direct feedback from the market a first version of the programme (see Chapter 3) has been realized.

A first review with the project teams involved in WP 5–WP8 will be held more than 6 months prior to the first training (February 2018). A second review on the entire programme will be held during the Full Project Meeting in Berlin in May 2018. These combined steps will lead to a “final” programme, which will be the basis of the marketing activities, being available at least 5 months before the start of the first course. However, as can be seen in the activity list (Table 1), experience teaches us that adaptations will be made in the programme (adjustment of a topic, a new lecturer or modifications in the case), based on feedback, market developments or specific regional issues. This means that the eight courses in general will be the same, but there might be adjustments between the different editions of the programme due to regional market developments or special wishes from target groups. This implies content and length will become customized per edition.

**Table 1:** Planning of content activities

Activity with regard to content	Time prior to the course		
	Current status	< 5 Months	Continuously
Define course objective, target group as well as participant assessment and specify learning methods applied	X		
Development of a concept programme based on input of experts and desk research	X		
Discussion of first draft extensive network of lecturers of EDI in conjunction with experts from the various consortium partners		X	
Presenting “final” programme to project group		X	
Incorporate the results of the evaluation of previous editions (selective, based on EDI experience)			X
Update the programme based on the new market developments.			X
Check programme adjustments with the market and developments within STORE&GO			X
Customise programme based on target group and regional market developments			X
If applicable, revise and update learning material			X

## 2.2 Lecturers

With its history as a business school EDI has built up an extensive network of EDI lecturers, who can be involved in the programme “Power to (the) molecules – from technology to market uptake”. In addition, the STORE&GO partners are involved in the choice of the main themes and the development of course material. As visiting the demonstration sites is part of the programme, they will be closely involved in the organisation of these site visits. An overview of potential lecturers will be created at least 5 months prior to the course. The listed lecturers will be reached out upon via one-on-one meetings discussing the concept of the programme, their expertise, their lecturing skills and their potential role in the programme. Ultimately, the lecturers will be selected for each edition separately based on their availability and expertise, to ensure that the lecture profile fits the regional markets.

Once a ‘go’ moment is given to the course, an important role of EDI starts. EDI reaches out to all the lecturers of that specific edition and coordinates the content of the lectures. It is important to keep a clear structure in the programme, common thread between lectures, and therefore prevent overlap between the lecturers. Usually meetings or conference calls with several lecturers are needed to guarantee the quality of the programme. For the development of a new case study, EDI coordinates the process with the lecturer involved. Table 2 lists the main activities and contact moments with regard to the lecturers.

**Table 2:** Activities and contact moment with lecturers

Activities	Time prior to the course		
	< 5 Months	At 'go' > 1 month	Continuously
Contact potential lecturers from EDI's network and experts from STORE&GO consortium partners	X		
Establish a list of potential lecturers	X		
Come to agreements with lecturers w.r.t. material development and financial remuneration			
Contact lecturers about their availability w.r.t. lecturing in a certain edition	X		
Contact lecturers about the content of the programme	X		
Contact lecturers about go decision and give guidelines for their presentation from a content perspective		X	
Schedule a joint meeting with all involved lecturers within a training edition to secure the quality and flow of the programme		X	
Evaluate the course with the lecturers and provide feedback to the lecturers for further improvements			X

## 2.3 Learning materials

Learning materials facilitate the lecturers to efficiently and effectively bring forward complicated subjects such that it becomes better manageable for the participants. The materials will make the lessons more interactive and interesting, which helps the participants to remember what they have learned during the training programme. Several types of learning materials will be collected or developed for “Power to (the) molecules – from technology to market uptake”: presentations, articles, videos, quizzes as well as a business model in Excel. The materials will be brought to the participant via different methods, as part of the online learning programme, as part of classroom interaction as well as group casework. Table 3 gives an overview of important activities related to the development process of the methods and the learning material.

A first and important step in the development process is the design and structure of the learning methods (e.g. online, classroom, group work, site visits) used in the training. Chapter 3 elaborates on these methods further, however, the methods should be configured in a manner that they support one another.

For each edition of the programme, EDI prepares an online environment that intends to prepare participants for the training by pre-reading articles, a selection of open-source as well as newly developed videos, interactive games, questionnaires and assessments. This ‘material package’ must be ready shortly after a ‘go’ decision is taken. All pre-reading material will be checked with the lecturers of the individual editions. As the online learning programme is part of the entire course, at least 6 months prior to the start of the course, the design and structure of the online environment must be determined. The entire programme will be presented during the general meeting in May.

During the class-room training, lecturers will be asked to use PowerPoint presentations. EDI will coordinate the development process of these presentations in close collaboration with the involved lecturers such that the common theme is maintained through the complete programme and that any doublings in content are prevented. The presentations will use similar templates to ensure consistency through the training, and will be shared with the participants through the online environment. Group casework provides participants an opportunity to apply the gained knowledge. The two main types of cases used within EDI are role-play and business modelling. The decision for the type of casework will be taken at least 6 months prior to the start of the first edition. Based on the type of casework, EDI will develop learning materials that supplement the case, such as a case description, excel models, geographical maps, diagrams and charts. Case material will be developed in conjunction with the STORE&GO consortium partners.

**Table 3:** Development process of learning materials

Activity	Time prior to the course		
	Current status	< 5 months	< 3 months
Final decision on course format incl. learning elements	X		
Decide on the type of casework	X		
Decide on the format of the online environment		X	
Develop the case in alignment with the lecturers		X	
Develop design of the online environment		X	
Selection of content for the online environment and if needed develop new material			X
Coordinate the development process of presentations in close collaboration with the involved lecturers			X
Coordinate training activities at the site visit			X

## 2.4 Marketing

The main objective of “Power to (the) molecules – from technology to market uptake” is to disseminate the knowledge and experience gained on large-scale energy storage technologies during the project STORE&GO. EDI will develop marketing materials, such as a brochure, which can be distributed within the partners of STORE&GO and also within the network of EDI, to ensure that the training reaches out to a wide public. The marketing materials will be available in printed form and also in digital form according to the rules of the STORE&GO Project. The brochure will include detailed information about the content of the programme, target group, lecturing team etc.

Besides a brochure, EDI will market the training programme on its webpage and on the website of STORE&GO, where information will be given including programme and practical details. A link towards the digital brochure will be put on this webpage. Moreover, the website will include an option



for potential participants to show their interest in the programme and to put them on the short-list for one of the course-editions. This short list can be used to select the participants based on their experience, skills and affiliations, to compose groups on an international basis to the extent feasible. An overview of all marketing and promotion activities is given in Table 4.

**Table 4:** Development process of marketing materials and promotion activities

Activity	Time prior to the course
	< 3 months
Market research on companies/parties that might be interested in participation	X
Write brochure and marketing text for promotion and share this within the STORE&GO consortium	X
Develop registration/selection tool	X
Send dedicated mailing to potential participants build up by market research and stakeholders from the consortium partners	X
Selection of participants on the basis of their experience, skills and affiliations, groups will be composed on an international basis to the extent feasible	X

## 2.5 Logistics

All eight editions of “Power to (the) molecules – from technology to market uptake” are planned to take place nearby the demonstration sites of STORE&GO (Falkenhagen, Solothurn and Troia). Some of these locations might have suitable rooms to host the classroom activities. However, when this is not the case, EDI is responsible to arrange suitable locations as well as transport to the site visits. Additional logistics such as transport and accommodation for lecturers and participants need to be arranged after the go-decision has been taken. Table 5 gives an overview of the main logistic activities. During each edition of “Power to (the) molecules – from technology to market uptake”, a project manager of EDI will be on location to make sure that the training runs smoothly.

**Table 5:** Logistic process and activities

Activity	Time prior to the course	
	< 3 months	At “go” > 1 month
Contact locations for potential hosting of the editions	X	
Confirm accommodations in case of a go-decision (both hotel and course location)		X
Arrange local transport to site visits		
Inform participants and lecturers about the logistics		X
Run day-to-day operation during the training		X

## 3 Training programme requirements

### 3.1 Learning targets and outcomes

The goal of “Power to (the) molecules – from technology to market uptake” is to get participants acquainted with the most important technical, economic, regulatory, spatial, environmental and social aspects of large-scale energy storage techniques and more specific the methanation process. They will not only learn about the diverse technologies and processes available, but they will also learn more about the integration of syngas in the natural gas grid, and its value provided to balancing the supply and demand of the renewable energy resources. The participants are expected to gain a solid understanding of how technological, regulatory and other institutional concepts relate to such business cases and their implementation.

At the end of the 3-day training, the participants will be able to:

- Understand the main technical, economic, regulatory, spatial, environmental and social aspects to methanation technology;
- Develop a sustainable energy case, and reflect on the chosen approach with reference to the location, technology and market offtake chosen. The participants are expected to work in teams and convincingly present and defend their methanation business case and the underlying analysis;
- Analyse and assess the feasibility of business cases based upon the combination of expected return, uncertainty, risk and feasibility in the context of a possible wider portfolio of economic activity;
- Understand the technological process of demonstrated technology installed on one of the three demonstration sites.

### 3.2 Target group – orientation and level

“Power to (the) molecules – from technology to market uptake” is especially developed for professionals working in or related to the energy industry. Participants could come from different fields (e.g. regulators, policy makers, engineers, and/or business developers) as well as from different sectors (gas industry, electricity suppliers, government and industry suppliers). The intention is to bring forward an interdisciplinary group to ensure discussions covering the different aspects of the methanation value chain, and such that each of them could contribute in their field of work.

An overview of the main target group:

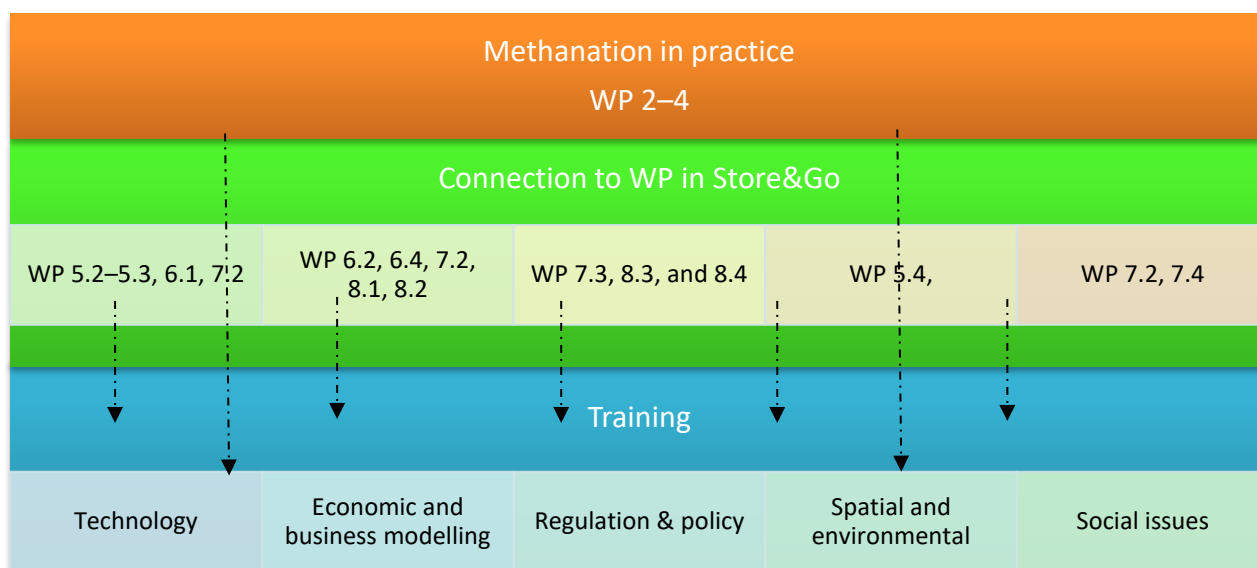
- Policy makers in the field of energy from regional, national and European level;
- Business developers in the field of energy storage;
- Technological engineers in the field of electrolysers, methanation and/or CO<sub>2</sub> capture;
- Transmission system operators of both the gas as well as the electric grid;
- Gas and electricity traders;
- Large industrial consumers;
- Financial and knowledge institutes as well as university lecturers.

The courses and the course material will in principle be held in English. Dependable on the group composition the course might be given in a different language, however, this strongly depends on the fluency of the lecturers in the language chosen. In case of an over-subscription, participants will be selected on the basis of their experience, skills and affiliations, to compose groups on an international basis to the extent feasible. To guarantee a good level of interaction between the

lecturers and the participants, the training programmes are organised for groups of 20 participants at most.

### 3.3 Training programme content

Figure 1 provides a full overview on how the training concept and especially how the content taught relates to the activities executed in the other work packages of this project. In this sense, coordination of the dissemination activities of the demonstration sites as well as the research activities may be guaranteed. Regarding the training content, the following distribution is applied: technology & system integration (30%); Economics, business cases and market outlook (30%); Regulation and policy (10%); Spatial and environmental issues (20%) and social issues (10%).



**Figure 1:** Connectivity of training activities to work packages

### 3.4 Programme assessment

All participants will receive a certificate of completion if, and only if, they complete 80% of the training programme, this includes the exercises from the online environment.

In addition, certificates would only be provided to those who:

- completed at least 80% of the online environment;
- participated in the case assignment;
- participated in the site visit to the demonstration site.

### 3.5 Teaching methods & materials

The programme “Power to (the) molecules – from technology to market uptake” applies blended learning, which together will ask 3 days of the participants’ time. Blended learning combines the benefits of student-teacher discussions in the physical classroom with additional online learning resources. When blended learning is properly applied, the best of two worlds are combined and performance is increased.

Next to this, our training programmes aim for a perfect balance between practical business experience and academic knowledge. EDI’s teaching staff consists of industry experts who provide relevant knowledge of the industry that bridges the gap between theory and practice. We use a problem-

based learning method that includes examples and case studies from the industry that provide context for the subject matter. During the 3-day course we intend to realise this by knowledge application through case work and a site visit to one of the demonstration sites. To realise a good balance between the different teaching methods, corresponding learning materials must be developed.

### 3.5.1 Online learning programme

The goal of the online learning programme, as part of the blended course “Power to (the) molecules – from technology to market uptake”, is to make sure that all participants start from a common ground, meanwhile giving EDI as well as the lecturers an idea of the knowledge level in general.

To facilitate the online programme, Cross Knowledge will be used. Cross Knowledge is an online environment, which gives room for individual assignments, discussion polls, quizzes and many more. Moreover, via the administration part of the programme, EDI would be able to track individual progress, total time spent as well as coaching opportunities and discussion sessions. As discussed in Chapter 2, a decision has to be taken on the design and structure of the online environment. This will basically be on whether we would have single or multiple learning paths.

Regardless of the design, participants will start online with an introduction into the World Energy Outlook and more specific in the European energy market thereby highlighting the need and potential for large-scale energy storage technologies. Next to that, the platform will offer participants an introduction into the concept of power-to-gas, which forms an important basis for the in-depth discussion during classroom activities.

The online environment will be available to the participants 1 month before the start of the course (Table 6). Participants are expected to read the provided learning material, and their knowledge will be tested through questionnaires and self-assessments. As a result, participants will start off the training programme with common understanding of the rationale and principles of large-scale storage technologies. During the online course, participants will be stimulated to start discussions and to finalize all their activities. During the classroom activities, we will start off where the online environment let off and shortly recap their online activities. The online programme will ask max 4 hours of the participants time, so half a day.

**Table 6:** Activities online environment

Publication Date	Timing	Content	Type
4 weeks before course	Before course (pre-work)	Welcome letter and introduction to the programme	Reading (max. 5 min.)
3 weeks before course	Before course (pre-work)	Background information and introduction into energy systems as well as technologies.	(Reading) exercise (max 60 min.)
2 weeks before course	Before course (pre-work)	Preparation of assessment that will be discussed during the programme	(Reading) exercise (max 120 min.)

### 3.5.2 Classroom activity

The classroom training will have an interdisciplinary character, and the content is strongly related to the testing and implementation activities in the project. The participants to the programmes become informed about the various technical, economic, regulatory and social aspects that are relevant to this energy conversion/storage technology. The programme (see 7) is set up to put the technology

into the wider perspective of the energy system, and to analyse what constitutes its business case and long-term perspective in contributing to a future sustainable and reliable energy system in Europe.

**Table 7:** Concept 3-day training programme

Day	Time	Content
Day 1		<i>Power-to-gas essentials: technology and market outlook</i>
	08.30 – 09.00	<b>Transport from the Hotel to the course venue</b>
	09.00 – 09.30	<b>Introduction and outline to the programme</b> - Official opening of the course and recap online material
	09.30 – 10.30	<b>The rationale power-to-gas and methanation</b> - European Energy outlook, gas developments and rise of renewables. - Challenges with renewable power production, power excess and interruptible power production - Limitations of power transmission and potential of natural gas grids
	10.30 – 11.00	Coffee break
	11.00 – 13.00	<b>Methanation technology in a nutshell</b> - Introduction of different types of methanation technology, balance of plant components, and their design specific assessments - Comparison on methanation technology /co <sub>2</sub> capture technologies w.r.t. efficiencies, load profiles and performance indicators - Outlook for techno-economic improvement in methanation and co <sub>2</sub> capture technologies
	13.00 – 14.00	Lunch
	14.00 – 15.30	<b>Utilization of synthetic gas in the natural gas grid and storage opportunities</b> - Blending hydrogen into natural gas pipeline networks, key issues w.r.t. centralized and decentralized production - Beneficiaries of syngas over hydrogen
	15.30 – 15.45	Coffee break
	15.45 – 17.30	<b>Economics and market potential for methanation</b> - Economies of the technologies and the business case for methanation in North West Europe - Dispatching value of power-to-gas combined with CHP and value for seasonality - Guarantees of origin and co <sub>2</sub> certificates
	18.00	Dinner and transport back to the hotel
		<i>Business aspects and forecasts for Power to Methane</i>
Day 2	08.30 – 09.00	<b>Transport from the Hotel to the course venue</b>
	09.00 – 10.45	<b>Spatial and environmental assessment</b> - Optimal location w.r.t. methane system integration (electricity grid integration, market offtake and co <sub>2</sub> source) - Environmental impact assessment of energy storage operation, incl. a risk analysis and LCA. - Public acceptance and engaging local environment.
	10.45 – 11.00	Coffee break
	11.00 – 12.30	<b>Regulatory barriers</b> - Applicable National and European legal regime, safety regimes and impact on the grid as well as authorisation procedures, conditions and administrative costs involved
	12.30 – 13.30	Lunch
	13.30 – 16.00	<b>Case work and presentation</b>
	16.00 – 16.15	Coffee break
	16.15 – 17.30	<b>Societal value of methanation</b> - Full cost-benefit analysis, incl. effects on employment, value added and sectoral impacts
	18.00	Dinner
Day 3		<i>Methanation in practice – visit to demo-site.</i>

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08.30 – 09.00	Transport from the Hotel to the course venue
09.00 – 10.30	<b>Introduction into the site visit</b>
10.30 – 12.00	<b>Process demonstration on site</b>
12.00 – 13.30	Closure lunch and certificates ceremony

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### 3.5.3 Case description

At the end of the second day, the participants will work in small interdisciplinary groups (max. 5 persons) to implement the core concepts from the various perspectives. In doing so, the participants have to apply theoretical concepts from the different fields. During the assignment you will have to apply all knowledge retrieved during the training, thus beside economic risks, one should identify the legal, social, technical and market risks. A business case should be developed, considering the following main elements:

- **Technological characteristics**  
The technologies available for methanation would not fit in all situations and technological improvements might quickly change the business case. Therefore, participants should argue the scenario taken by their team.
- **Location and market decisions**  
Given the characteristics of the central/decentral location, one should decide the offtake markets (e.g. feed-in / mobility sector). Moreover, potential offtake price depends on the willingness of the offtake to pay an add-on price.
- **Risk factors**  
Identification of potential risks associated with the investment decision. Part of the risks would be associated with regulatory aspects and social acceptance.

### 3.5.4 Demonstration sites

The demonstration site plays a key role in the training courses as it helps the participants to envision the technologies and process discussed during the project. Although the technological processes installed on these sites differ, the concept of large-scale energy storage technologies and its solutions offered to the region cannot be better explained than on the locations itself.

## 4 Conclusion

This Deliverable shows the developmental steps that need to be taken to come to the three-day training programme “Power to (the) molecules – from technology to market uptake”, as well as the preliminary outcomes of the first steps in the development process. The first two editions of the training are expected to take place in autumn 2018. At this time, the demonstration sites are expected to be in full operation, and first conclusions on their processing could be shared with the participants.

The first tasks of development (identification of objective, target group identification, selection of main learning methods as well as the development of a concept programme) have been completed and are currently tested by market parties. This is important since market relevance should be guaranteed to make the dissemination a success. Another potential risk is the lack of contribution to the content of the programme by consortium partners or experts within the EDI network. EDI will minimize these risks by aligning all partners and experts from the beginning of the development process.