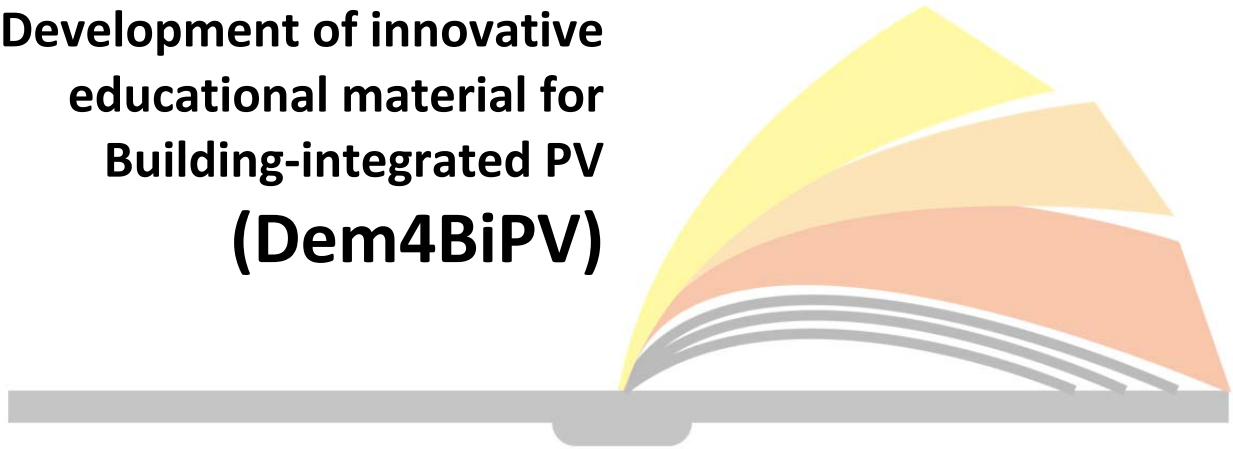
Curriculum Manual

Development of innovative educational material for Building-integrated PV (Dem4BiPV)



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Consisting of

Coordinator:	Utrecht University	The Netherlands
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Summary

This curriculum manual gives an elaborate overview of all study material that has been developed and / or gathered as part of the European Dem4BIPV project. This project is a joint initiative of several universities in Europe (Utrecht University, University of Cyprus and the University of Applied Sciences in Vienna) and companies specialized in renewable energies (Deloitte, WIP Renewable Energies several universities in Europe and companies specialized in renewable energies. The ultimate goal of the Dem4BIPV project is to create awareness in BIPV and to inspire young talent to become BIPV specialists. This is done by bringing knowledge and skills of graduate students closer to the labor market needs in relation to BIPV system installation.

The curriculum consists of 6 modules; General introduction, Photovoltaics, Environmental impacts, Architectural Aspects, Energy in Buildings and Future perspectives. The full curriculum covers in total more than 40 ECTs (≈1120 hours) of study material.

Chapter 2 explains how each module contains a module syllabus, different courses, assignments and reading material. The next chapter provides a brief overview of the contents of each module, describing its learning goals , course contents and assignments. Recommendations on how to study the curriculum are given in the last paragraphs of this chapter.

The backbone of every module is the module syllabus, in which the content of each module is described. The syllabus provides an introduction to the module, information about the teaching methods and assignments, a literature list and a list of references and acknowledgments. The complete content of each course syllabus is given in chapter 4 to 9.

Each module has one or more assignments. In these assignments students make the link between BIPV and the knowledge and skills gathered in the courses. The remaining chapters of this manual contain all assignments that have been written for the Dem4BIPV curriculum.

Contents

1 Introduction

The European Dem4BIPV project has been conceived as a joint initiative of several universities in Europe (Utrecht University, University of Cyprus and the University of Applied Sciences in Vienna) and companies specialized in renewable energies (Deloitte, WIP Renewable Energies) to improve the quality of BIPV education at university level. The goal is to bring the knowledge and skills of graduate students closer to the labor market needs in relation to BIPV system installation. Ultimately, the Dem4BIPV project aims to create awareness in BIPV and to inspire young talent to become BIPV specialists.
In order to achieve these goals, a ~40 ECTS master-curriculum focusing on BIPV is targeted for various European academic institutes.

The curriculum consists of 6 modules as shown in the figure below. The following chapter explains how every module is structured. The remaining chapters provide a brief overview of the content of every module.

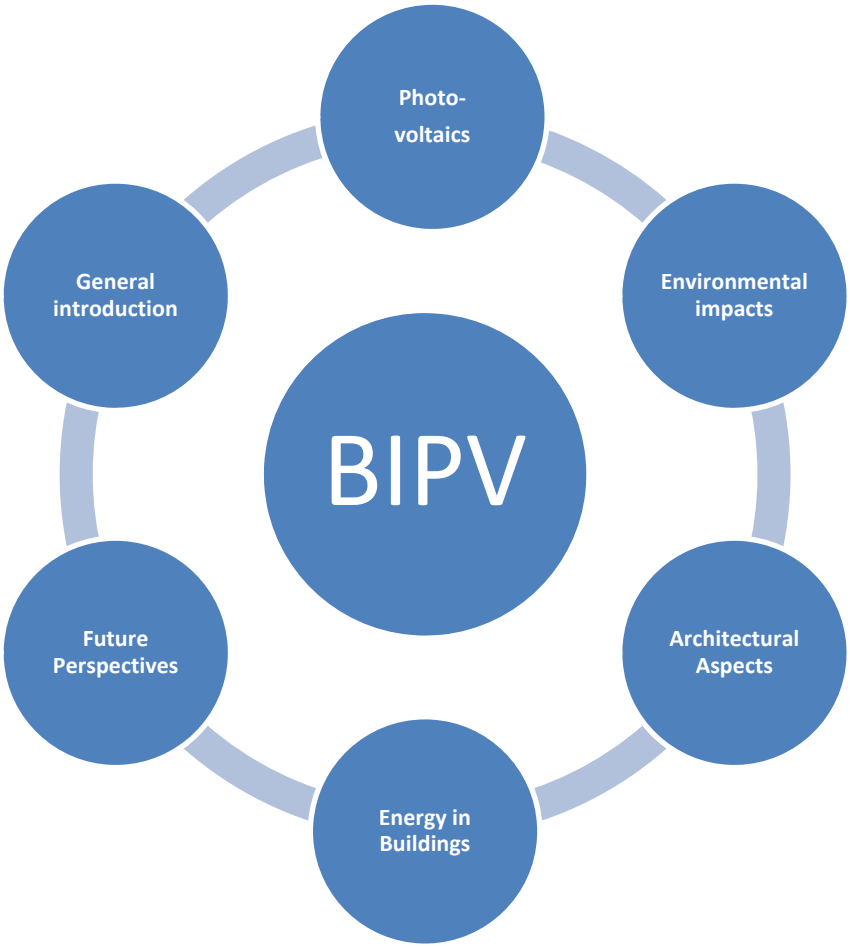

Figure 1 : The 6 modules of the BIPV curriculum

2 General content of each module

Each one of the 6 modules of the BIPV curriculum has a structure as shown in the figure below. The following paragraphs a short explanation for each element.

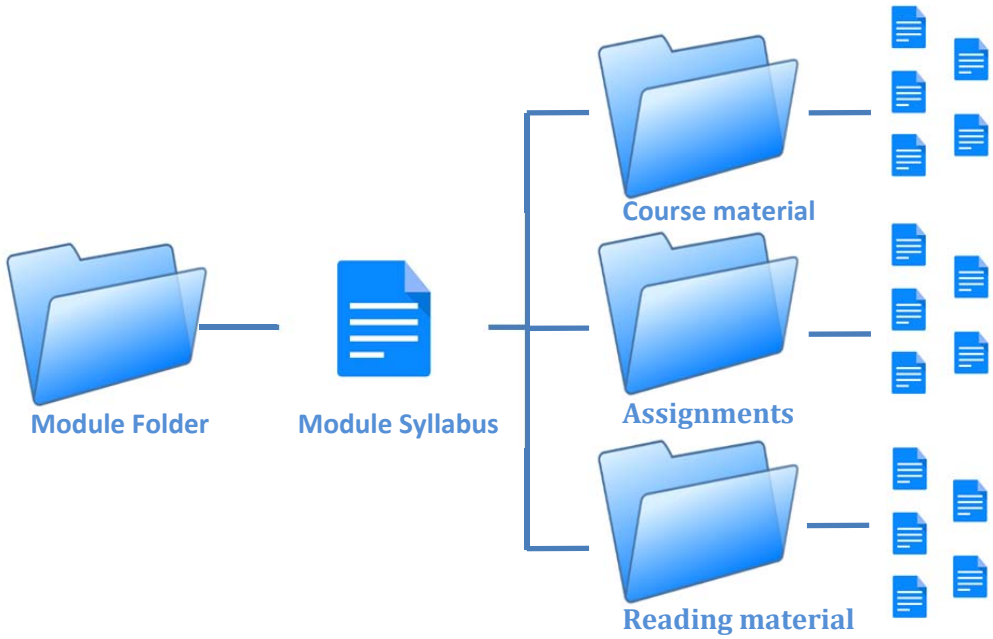

Figure 2 Structure of the modules

2.1 Module syllabus

The backbone of each module is the module syllabus, in which the content of the module is described. The syllabus provides an introduction to the module, information about the teaching methods and assignments, a literature list and a list of references and acknowledgments.

Not every course in every module has to be followed. For some modules a distinction is made between 'basic', 'standard' and 'advanced' courses. Instructors or students can decide what courses are most relevant for their situation with the help of the syllabus. Further on, possible excursions or additional events that are relevant to the content of the module are listed in this document. Chapters 0 to 9 of this course manual provide the same information as the course syllabi.

2.2 Assignments

Every module consists of a folder with different courses and assignments. Most of the courses have an important relation to BIPV, but are not written as a course on BIPV specifically. Therefore each module has one or more assignments. In these assignments students make the link between BIPV and the knowledge and skills gathered in the courses. The assignments can also be found in the chapters 10 to 19 of this document.

2.3 Course material and MOOCS

A large part of the course content is based on MOOCS (Massive Open Online Courses). This way high quality course material is created, maintained and (possibly) graded by universities specialized in their respective fields. The MOOCS generally consist of short lectures, assignments, forums and

exams and can be followed by the students at the time, place and pace they prefer. By utilizing MOOCS, an important part of the study material can be given by universities without having all specific knowledge 'in house'. Instructors or tutors mainly guide students through the study process and organize the assignments. Beside the MOOCS, courses including lecture sheets and assignments are available to be given as 'normal' classroom courses. These contents, together with an overview of each MOOC can be found in each course module.

2.4 Reading material

Beside the course material and assignments, a library with reading material is provided with every module. To keep this material up to date, students are also invited to find new material as part of the assignments. A list of the reading material is also provided in the course syllabus.

2.5 BIPV introduction course

The BIPV introduction course is part of the general introduction module. This course consists of 4 lectures an assignment and an exam. The course provides a general overview of the most important topics of BIPV.

The topics of the 4 lectures are:

- Introduction to BIPV
- Influences on electrical performance
- BIPV vs conventional construction and environmental impacts
- Market development and Aesthetics

The assignment consists of 2 parts. In part A of the assignment, students are invited to renovate a 22 story building with BIPV elements. A software tool (PVSITES) is used to calculate the performance of the system. In part B students write a business case to convince the building owners to carry out the renovation of part A.

3 Overview of the modules

This chapter provides a quick overview of the contents of each module. It describes the learning goals, course contents and assignments. A more elaborate description of each module can be found in chapters 0 to 9

3.1 General introduction

3.1.1 Learning goals

After successfully completing the module the students:

- Understands the principle of BIPV and know all the relevant aspects of this topic.
- Has knowledge on the basic concepts of climate change and the relationship between the anthropogenic increased greenhouse-effect and global warming.
- Knows the current energy mix and its main actors.
- Understands the future energy mix-scenarios and realizes the foreseen role of renewable energy, especially PV and BIPV.
- Is conscious of the potential of BIPV and its advantages & barriers.

3.1.2 Courses

	Topic	Courses	Study load (hours)	ECTS (1= 28 hours)
Basic	Global Warming	Climate Change	18	0.6
	Energy Mix	Video: Controls on the Global Energy Mix	1	NA
Standard	Global Warming	Climate Change: The Science	47	1.7
	Global Warming	Sustainability in Everyday life	42	1.5
	What is BIPV	Introductory Course	8	0.3
Advanced	Energy Mix	Politics and Economics of International Energy	24	0.9

3.1.3 Assignments

Assignment	Study load (hours)	ECTS (1 = 28 hours)
Literature Review	80	±3
Poster Presentation	28	1
PVsites-assignment	28	1

3.2 Module: Photovoltaics

3.2.1 Learning goals

After successfully completing the photovoltaics module, the student:

- Knows how photovoltaic conversion physically takes place within solar cells
- Has insight into different PV technologies used for different BIPV-applications
- Knows how to analyze the performance of solar cells and modules
- Makes well informed decisions on what PV technology to use for different applications
- Is able to design a complete PV system for any application
- Understands how the position of the sun and solar irradiance has an effect on PV module performance

3.2.2 Courses & Assignment

Study level	Courses	Study load (hours)	ECTS (1 = 28 hours)	Total ECTS
Basic	Introduction course	34	1,5	1,5
Standard	ET3034x	64	2,3	2,3
Advanced	PV1x	100	3,6	17,2
	PV2x	110	3,9	
	PV3x	110	3,9	
	PV4x	90	3,2	
	PV5x	72	2,6	
Assignments	PV integration assignment	40 - 62[1]	1,4 – 2,2	1,4 - 2,2
	Remote labs assignment	12	0,4	

3.3 Module: Environmental Impacts

3.3.1 Learning goals

After successfully completing the module students:

- Understand what the main environmental impacts from BIPV are
- Understand how to determine the environmental impacts from BIPV
- Know the concept of a circular economy, based on its socio-technical, organizational and environmental characteristics
- Recognizes the difference between a linear and a circular economy
- Are able to assess the use of LCAs and ABMs
- Are able to use the research methods and tools to assess and improve the environmental impacts of products

3.3.2 Courses

Courses	Study load (hours)	ECTS
Toolbox 1	112	4
MOOC: Circular Economy	150	5.4

3.3.3 Assignments

Assignment	Study load (hours)	ECTS
CO_2-footprint	24	0.9
LCA Review	60	2.1
SimaPro	28	1

3.4 Module: Architectural Aspects

3.4.1 Learning goals

After successfully completing this module the student

- Knows how to read, analyze, and understand different forms of architectural representations
- Understands the social and historical contexts behind architecture

[1] Depends on group size, amount of examples (see assignment)

- Has an understanding of how architects see and shape the built environment
- Understands the interdisciplinary context of sustainability and architecture
- Understands how cities are formed and how to maintain livability in future cities
- Understands where BIPV meets and where it jeopardizes the views of the architect
- Understands what is required from and by the field of architecture to implement BIPV on a larger scale

3.4.2 Courses & Assignment

Courses	Study load (hours)	ECTS
The Architectural Imagination	50	1,9
Sustainability in Architecture	16	0,6
Future Cities	30	1,1
Quality of Life: Livability in Future Cities	33	1,2
Architecture integration assignment	28-56	1-2

3.5 Module: Energy in buildings

3.5.1 Learning Objectives / goals

After successfully completing this module the student:

- Understands how environmental elements influence the energy flows in a building, including:
  - Heat flows
  - Lighting (natural / artificial)
  - Ventilation (passive / active)
  - Solar energy (passive / PV)
  - Acoustics
- Understands how the design of a building influences the aforementioned elements
- Knows what kind HVAC systems to choose for different situations
- Is able to make a detailed energy model for a simple building
- Is able to use specific software for energy modelling and PV generation
- Understands how the implementation of BIPV influences the energy flows in a building
- Knows where to find local building rules and regulations and how to apply them

3.5.2 Study load

The study load for this module is dependent on the chosen courses. The table below shows what courses and assignments can be taken to reach different study levels. The study load for each course within this module and the cumulative load for each study level is also shown in this table.

Study level	Courses	Study load (hours)	ECTS (1 = 28 hours)	Total ECTS
Basic	Energy in buildings	10	0,3	0,3
Standard	Introduction to Building Technology	103	3,6	
	Zero Energy Office assignment Part 1	72 - 252	2,6 – 9	6,5 – 12,9
Advanced	Honeybee Energy Modelling	33	1,2	
	Zero Energy Office assignment Part 2	72 - 252	2,6 – 9	10,3 – 23,1

3.6 Module: Future perspectives

3.6.1 Learning Objectives / goals

After successfully completing the module the students:

- Are able to identify potential future sustainable business roles
- Understand how new technologies can influence the market and society
- Know how to identify key business opportunities in the field of renewable energy sources and green building-sector
- Understand the concepts of the MLP and the TM-theory
- Have developed their own vision on the requirements to make sure BIPV develop out of its own niche
- Knows the current state of BIPV and the future perspectives of this technology

3.6.2 Courses & Assignment

Courses	Study load (hours)	ECTS
Impact of technology	39	1.4
Renewable Energy & Green Building Entrepreneurship	11	0.4
Future Perspective Assignment	116	4.1

3.7 How to study the curriculum

Even though all modules of the curriculum share BIPV as main topic, the curriculum content is designed such that each module can stand on its own. This means that

- The sequence of the modules is not very important, modules could also be studied simultaneously.
- In case a certain module is not of interest, it can be skipped
- According to the desires of the student or tutor, different modules can be studied at different levels (for example Photovoltaics at advanced- and Energy in Buildings at standard level)

Nevertheless, to have an initial overview it is recommended to **start the whole curriculum with the introductory course on BIPV** (from the module General Introduction). Further on, it is recommended to study the modules Photovoltaics, Architectural Aspects and Energy in Buildings in the order as written here.

3.8 How to study the modules

As described earlier the course syllabi describe how the courses and assignments should be taken for each module. The content of these documents are also provided in the 6 following chapters.

You've reached the end of this document. For the full curriculum manual and more course material please contact us.

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