Training: Sustainable Chemistry and Power-to-Chemicals (PtC) (by ISC3 and PtX Hub)

Concept

2 days: Sustainable Chemistry and Power-to-Chemicals

The training consists of two days: Day 1 covers the analysing of the conceopt of Sustainable Chemistry and its multiple dimensions and supporting elements. It is provided by ISC3. Day 2 is devoted to specific PtX-products (PtC), input resources, production, transportation and storage and is provided by PtX Hub. The training (specifically day 2) has a relatively high requirements concerning the background knowledge of the participants.

Day 1: Sustainable Chemistry

Time:

- 1st day: 4,5 hours, 2nd day: 5 hours.

Scope and participants:

Up to 30 professionals working in renewable energy (RE) and /or PtX topics:

- Teachers, lecturers in the field of engineering, chemistry, energy, renewables
- decision makers (ministries, regulators)
- researchers
- representatives of industry and associations
- NGOs

Objectives:

1. **Awareness Raising** and **training** of the stakeholders in different aspects of Sustainable Chemistry. Focus on the most important PtC products and the processes. Bringing all participants to a common knowledge level.
2. **Guidance** for countries and stakeholders to achieve **Sustainable Chemistry**. Development of a common understanding as narrative for the development of PtX-economy. A common work throughout the value chain in the target country is framed in **national plans** for sustainable & inclusive development along with the Agenda 2030 and the UN SDGs.
3. Drive attention and deliver insights to **unattended sustainability aspects (holistic approach) of Power-to-X.** Developing **c**ritical understanding of the transformation in the energy sector regarding sustainability aspects and obtaining ability for long-term planning including towards sustainability.

At the end of the training, participants will have:

- **key terminology related to SC,** understanding of context and recent developments
- ability to assess **applications and processes** as well as future usage options to substitute current fossil industrial processes
- an overview over the most important PtC products: ammonia, methanol, methane and their production processes
- critical thinking about the processes related to energy and chemistry and their possible side effects
- developed the ability to evaluate SC and PtX in a **holistic approach**
- understood the crucial starting points and instruments to **foster and regulate SC** from the political & institutional frame

Set-Up:

- Presentation material by ISC3 (in Engl)
- Interactive parts
- Certificate for participants

Methodology:

- Interactive **training** (75/25: lecture/interactive parts)
- Focus on SC and sustainability aspects as well as PtC products ammonia and methanol
- Structured interactive parts & group work (polls to predefined questions)

Introduction:

Chemical sector plays a vital role in today's world. Chemicals in different branches contribute to the current living standards. About 140.000 of chemicals are marketed in the world. The exponential growth of chemicals pollution is a source of serious concern, exposing public health and environment to severe risks from hazardous substances. The resources of our planet are getting scarce. Business as usual is no longer an option. A transformation towards sustainability in the chemical sector is urgently needed. The UNEP's Global Chemicals Outlook II points out: "Driven by global megatrends, growth in the chemical-intensive industry sectors (e.g. construction, agriculture, electronics) creates risks, but also opportunities to advance sustainable consumption, production and product innovations." Furthermore, sustainability-driven innovation and digitalisation have the potential to substantially

contribute to establishing circular business models, enhance traceability and promote the change towards low carbon energy and feedstock in the chemicals sector. As the GCO-II recognises, accelerating progress is possible, yet only under a sustainability scenario. The chemical sector needs to be assessed throughout the whole life cycle of products. Chemical solutions have to be fostered that are benign-by-design and promote new sustainable business models and services.

Transitioning towards a green and sustainable chemistry requires new systems thinking approach. It implies to replace the current linear commodities-based take-make-consume-dispose approach with a closing-the-loops benign-by-design approach kept within the planetary boundaries. Sustainable chemistry practices embrace green chemistry and are based on considering the whole life-cycle of substances and materials while looking at waste as a valuable resource to be safely re-used. By following the sustainable chemistry approach, companies and entrepreneurs embark a journey towards re-thinking not only their product assessment and product stewardship schemes, but also towards re-designing their research and development activities and, also, their overall business strategy.

As a source of inspiration for innovation, sustainable chemistry has the potential to be even more than a transformative element in the chemical sector: as orientation and conceptual approach it supports scientists, entrepreneurs and start-ups, especially in developing countries, to develop new products and processes which are purpose-driven and add value to our societies. Hereby the concept supports economic development and entrepreneurship in developing countries as well as in emerging and industrialized economies, based on the overarching goals of sustainable development.

Furthermore, sustainable chemistry offers guiding principles for the development of enabling policies for green-tech, eco-design, consumer and worker protection and the sound management of chemicals and waste on the national as well as on the international level. Fostering the emerging concept might therefore be an important asset to speed up the sound management of chemicals and waste. An ambitious framework for SMCW beyond 2020 should profit in many ways from integrating and reaping the full potential of green and sustainable chemistry.

All in all: Sustainable Chemistry is a long-term global process that transforms chemicals management, substances, processes, services and innovations to serve the Agenda 2030 for Sustainable Development and its goals (SDGs). Sustainable Chemistry needs the commitment of all stakeholders and sectors using or dealing with chemicals.

Content:

1. **Sustainable Chemistry**

- Chemistry and dimensions of sustainability
- SDGs, planet boundaries and resources
- Conventions and regulations
- Green Chemistry, circular economy,
- 10 Key Characteristics of SC
- Sustainable Chemistry and Power-to-X
- Side effects, unattended issues
- New Business Models

2. **Power-to-Chemicals**

- Introduction ot Power-to-X
- Input: sources (energy, water, CO2, metals)
- Power-to-Ammonia
- Power-to-Methanol
- Power-to-Fuels
- Power-to-Solids (Plastics)
- Other: personal care products

Agenda

Day 1: Sustainable Chemistry

Duration: 4,5 h (2 breaks)

5 minutes are reserved after each chapter and subchapter as a buffer-time for questions and interactive parts with the audience.

Day 1	**Title**	**Content**	**Duration (min)**	**Time**
	Welcome	Introduction	10	**09:00**-09:10
Chapter 1	Global megatrends	Global megatrends in population, resources, GHG, consumption, climate and plastic pollution	15	09:10 – 09:25
Chapter 2	Production, use and trade of chemicals	Basic knowledge about production, use and trade of chemicals, types of chemicals, chemical and health nexus, chemical accidents.	15	09:30 – 09:45
Break	Coffee break		15	09:50-10:05
Chapter 3	The concept of Sustainable Chemistry	Basic concept of SC: definitions, and surrounding elements	See below	See below
3.1	Sustainable Chemistry and SDGs	Surrounding elements of Sustainable Chemistry + discussion (question 1)	15	10:05 – 10:20
3.2	Collaboration, conventions	- Conventions, MEAs	20	10:25-10:45
Break		Lunch	70	10:50-12:00
3.3	Aspects of SC: GC	Green Chemistry	20	12:00-12:20
3.3	Basics of SC	10 Key characteristics, Circular Economy, Chemicals as a Service	30	12:25-12:55
Chapter 4	PtX and SC: sample applications, questions	PtX Intro, stages, applications, SC questions in PtX process	15	13:00-13:15
Feedback	Wrap Up of day 1	Summary and feedback by the audience	10	13:20-**13:30**

Day 2: Power-to-Chemicals (PtC)

Duration: 4:50 h (2 breaks)

5 minutes are reserved after each chapter and subchapter as a buffer-time for questions and interactive parts with the audience.

Day 2	Title	Learning objectives	Duration (min)	Time
	Introduction	Q&A for day 1, purpose of the day 2	15	**09:00**-09:15
Chapter 1	Introduction to PtX	What is Power-to-X, What will be the added value for you as participant?	20	09:15 – 09:35
Chapter 2	Key inputs and where to find them	Carbon Sourcing, Water, Hydrogen, Nitrogen. Introduction to potential applications	20	09:40-10:00
Chapter 3	Methanol	Power-to-Methanol	15	10:05-10:20
Chapter 4	Ammonia	Power-to-Ammonia	15	10:25-10:40
Break		Coffee break	15	10:45-11:00
Chapter 5	Fuels	Power-to-Fuels	15	11:05-11:25
Chapter 6	Plastics I	Power-to-Solids: Polymers	10	11:30-11:40
Break		Lunch	75	11:45-13:00
Chapter 7	Plastics II	Power-to-Solids: Polymers	10	13:00-13:10
Chapter 8	Cosmetics	Personal Care Products and future applications	10	13:15-13:25
End	Wrap up	Q&A, feedback, wrap up, certificates	20	13:30-**13:50**