

# › **ACCELERATING THE ENERGY TRANSITION WITH SYSTEMS ENGINEERING**

**Welcome!** Please do come in, and find a spot



The **SIG ENERGY WORKSHOP** starts at 15:00hr

## Workshop format

- › Short introduction and problem statement
- › Break-out sessions
- › Plenary report out
- › Wrap-up



**Marcel Willems**  
*Enexis*



**Frans Speelman**  
*Stedin*



**Teun Hendriks**  
*TNO*

The background features a pair of hands holding a glowing globe. The globe is composed of a network of white dots connected by thin lines, with two glowing lightbulbs in the center. The overall color scheme is dark blue and teal with bokeh light effects.

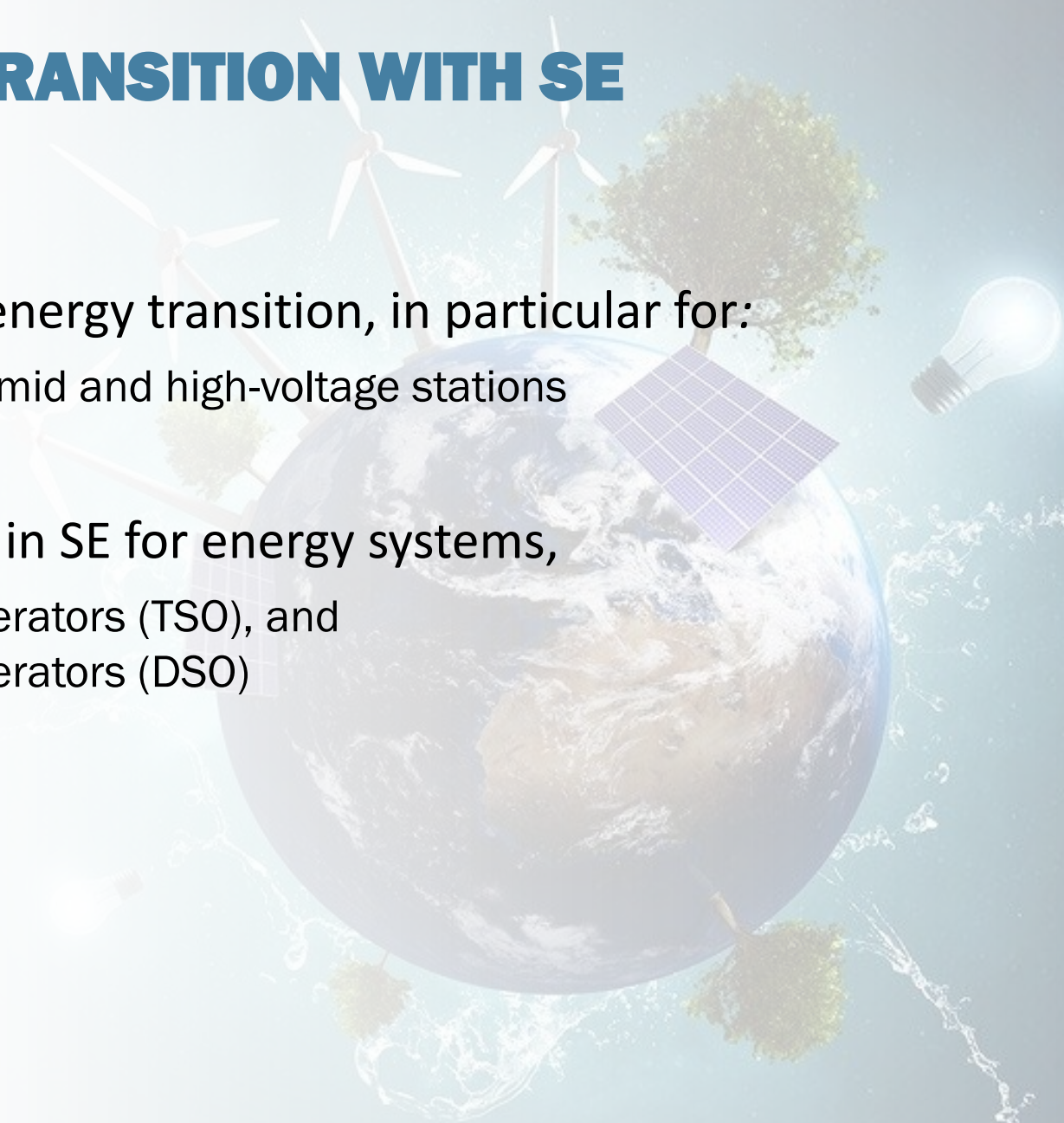
# ACCELERATING THE ENERGY TRANSITION WITH SYSTEMS ENGINEERING

*SIG ENERGY WORKSHOP*  
*INCOSE-NL DAY, 3 OCTOBER 2024*

# › **ACCELERATING THE ENERGY TRANSITION WITH SE**

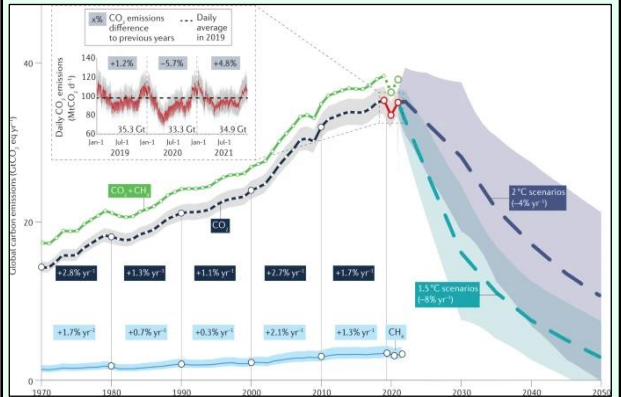
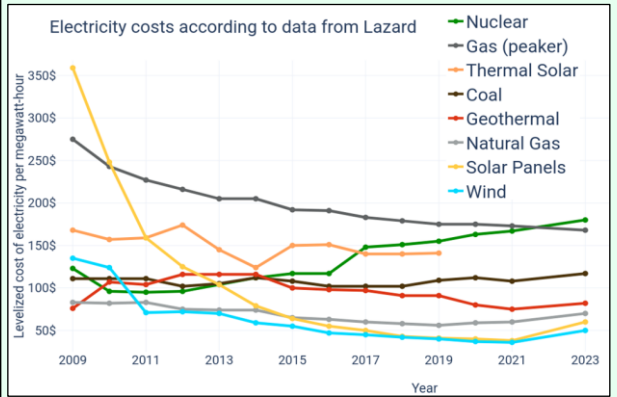
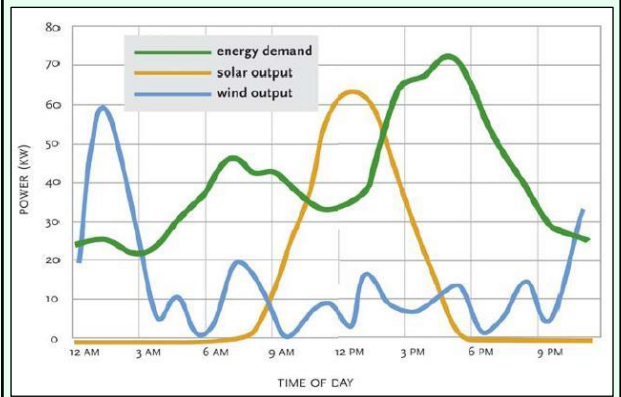
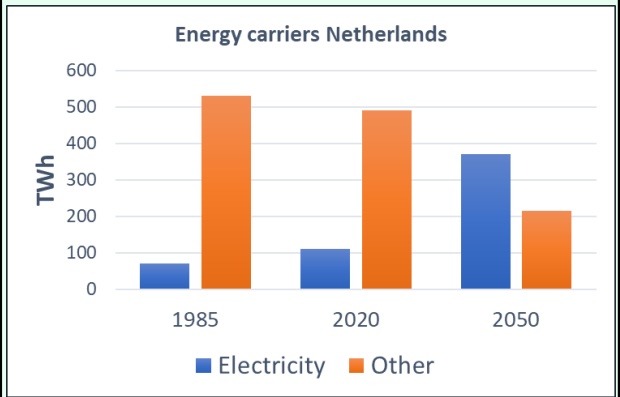
## **WORKSHOP OBJECTIVES**

- **Identify areas** where SE can support the energy transition, in particular for:
  - › Building and upgrading large quantities of mid and high-voltage stations
- **Share best practices and lessons learned** in SE for energy systems,
  - › In particular for: Transmission System Operators (TSO), and Distribution System Operators (DSO)



# THE ENERGY TRANSITION

## KEY DRIVERS AND THEIR CONSEQUENCES

Climate goals	Economic	Intermittent and unpredictable energy supply	Massive electrification
 <p>CO<sub>2</sub> emissions (MtCO<sub>2</sub>e) vs Year (1970-2050). Includes inset for daily CO<sub>2</sub> emissions difference.</p>	 <p>Electricity costs according to data from Lazard (2009-2023).</p>	 <p>Power (kW) vs Time of Day (12 AM - 9 PM). Shows energy demand, solar output, and wind output.</p>	 <p>Energy carriers Netherlands (TWh) for 1985, 2020, and 2050. Legend: Electricity (blue), Other (orange).</p>
<ul style="list-style-type: none"> <li>-55% in 2030; -100% in 2050</li> <li>Phase-out fossil fuels</li> <li>Shift to renewable sources</li> <li>Efficiency increase</li> </ul>	<ul style="list-style-type: none"> <li>Solar and wind now cheaper than gas or coal plants</li> <li>(Levelized cost of electricity)</li> </ul>	<ul style="list-style-type: none"> <li>40% electricity solar/wind in 2023; growing fast</li> <li>Demand → supply driven</li> <li>Flexibilization of energy</li> </ul>	<ul style="list-style-type: none"> <li>EV's, heatpumps, industry, ...</li> <li>Up to 5x increase in electricity demand in 2050</li> <li>Smarter use of infrastructure</li> </ul>



Unprecedented engineering effort in times of scarcity of experts and tight labor market

# › ACCELERATING THE ENERGY TRANSITION SCOPE AND CHALLENGES

## › Scope today: **mid- and high-voltage stations**

- › Transportation: 10 kV and higher
- › DSO/TSOs need to upgrade/add 100's of stations

## › The energy grid has a long history, lots of legacy

- › Rapid upscaling NOW,
- › Coping with a shortage of personnel

## › Major upscaling challenges

- › Building for rapid demand increase, while supply is decentralizing
- › Transport and supply of electricity must continue
- › Flex/curtailment versus meeting peak capacity → which balance?



# RAPID UPSCALING OF MID- AND HIGH-VOLTAGE STATIONS

## EXAMPLES: ENEXIS AND STEDIN PLANS

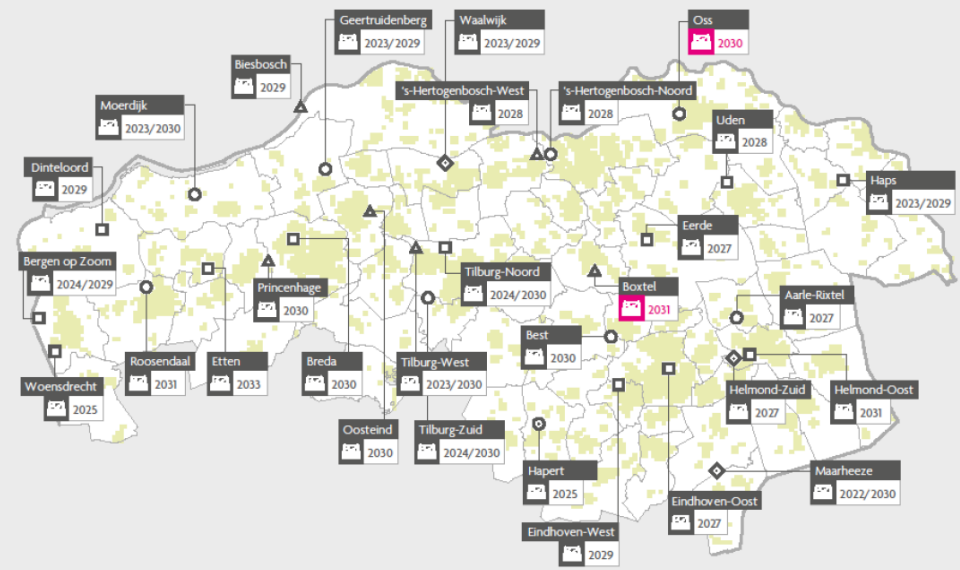
### Provincie Utrecht

Aantal belangrijke grootschalige projecten TenneT en Stedin tot 2030 uitgelicht.

Totale investeringen: 740 miljoen euro



### Investerings in hoogspanningsstations Noord-Brabant



#### Werzaamheden

Enexis Netbeheer plant actief om te investeren in de uitbreiding en nieuwbouw van hoogspanningsstations in Noord-Brabant. Zo breiden we de transportcapaciteit van onze elektriciteitsnetten in deze provincie uit voor onder meer de verwachte groei van duurzame elektriciteitsopwekking.

De overzichtskaart visualiseert:

- de individuele hoogspanningsstations in de provincie;
- het verwachte jaar dat de uitbreiding of nieuwbouw is gereed is;
- en totale verwachte elektriciteitsopwekking in 2030\* per individuele hoogspanningsstation.

#### Uitbreiding capaciteit bestaand station

De uitbreiding van de capaciteit van een hoogspanningsstation houdt meestal in dat Enexis Netbeheer hier een extra transformator en/of een extra schakelinstallatie plaatst. Het kan ook voorkomen dat een bestaande transformator wordt vervangen door een transformator met meer capaciteit.

Verwacht aantal uitbreidingen van bestaande stations in Noord-Brabant: **37**

#### Bouw nieuw station

De bouw van een nieuw hoogspanningsstation voert Enexis Netbeheer samen uit met de landelijke netbeheerder TenneT. Enexis Netbeheer zorgt daarbij voor de transformatoren en de schakelinstallatie en TenneT zorgt voor de aansluiting op het hoogspanningsnet.

Verwacht aantal nieuw te bouwen stations in Noord-Brabant: **2**

#### Totale verwachte elektriciteitsopwekking in 2030\* per individueel hoogspanningsstation

- ▲ 0MW - 200MW
  - ◆ 600MW - 800MW
  - ◻ 200MW - 400MW
  - ⊕ >800MW
  - 400MW - 600 MW
- \* Onze prognose van de verwachte hoeveelheid opwek in 2030 rond het betreffende station.

# › SIG ENERGY TRANSITION

## INCOSE-NL SPECIAL INTEREST GROUP

- Discusses **Systems Engineering** contributions in context of the **Energy Transition**
- Furthers the INCOSE-NL strategy
- Seeks connection to the wider INCOSE
  - › Presence planned at INCOSE IW25: Seville Spain
- SIG members include:
  - › DSOs/TSOs,
  - › Organizations working with the energy sector
  - › Research institutes, e.g. TNO
- SIG meets monthly, chaired by Harry van de Velde



INCOSE-NL Strategy topic	Description
Socially Relevant Issues	Actively stimulate SE contributions to <b>Socially Relevant Issues</b> .
Trustworthy Authority	Develop INCOSE-NL to a <b>Trustworthy Authority</b> on all matters SE in the Dutch ecosystems leveraging international networks.
Growth	<b>Grow</b> the INCOSE-NL network in absolute membership, active domains and partnerships.
Make SE Popular	Make the SE profession more <b>popular</b> by promoting and marketing SE.
Knowledge and Products	Offer useful <b>knowledge and products</b> to improve quality of SE application.
Professionalism	Make INCOSE-NL more <b>professional</b> .

# FUESSE STUDY - FUTURE ENERGY SYSTEM SYSTEMS ENGINEERING



The challenges imposed by the **energy transition** put a heavy societal pressure on the NL grid operators to **scale up** the capacity of the energy grid infrastructure.

This demands **smarter (digital) and more efficient ways to realize grid extensions** while keeping the existing infrastructure operational.

FuESSE is a joint study on what the current engineering state of practice in the sector is, and explores the benefits of **Systems Engineering (SE)** approaches to create more **synergy** along the grid operators' asset supply chain and between the grid operators themselves.





# › FOCUS VOOR FUESSE PROJECT FOR GRID OPERATORS, AND TNO

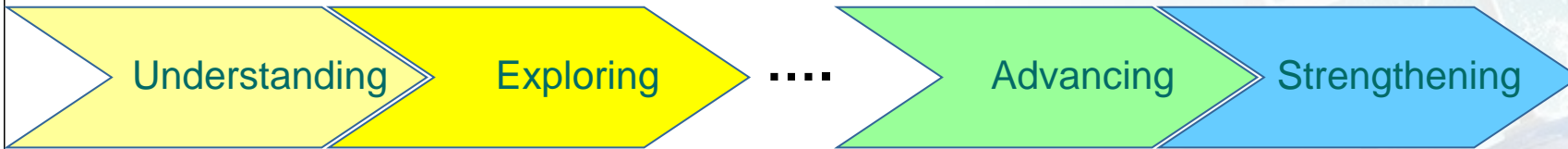


- › The main challenge of the FuESSE-project is how to:  
**mitigate the shortage of personnel**  
by **accelerating the creation process, and increasing workforce productivity, of**  
realisation of systems (stations) and their lifecycle-management.
- › Shared challenges are identified for:  
beneficial application of **Systems Engineering**

## Key topics discussed

- › **How to increase productivity** (by applying SE)?
- › **How to align, harmonise WoW** (and SE) across organisations

# FUESSE APPROACH: SCANNING AND DEEPENING WORKSHOPS AND DEEP DIVES ON SELECTED TOPICS



## Deep dive topics so far:

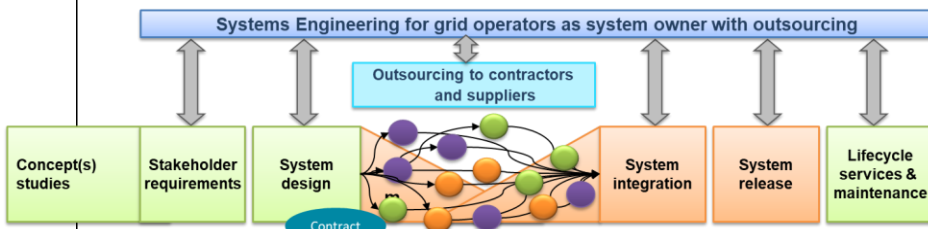
- › Modular building of stations
- › Competencies for SE lead engineers
- › Outsourcing of projects to contractors



Modulair opgebouwd: schakelstation Lelystad



Photo by Nathan Duck on Unsplash



CORE COMPETENCIES	PROFESSIONAL COMPETENCIES	MANAGEMENT
<p><b>Core competencies</b> underpin engineering as well as systems engineering.</p> <p><b>Systems Thinking</b> The application of the fundamental concepts of systems thinking to systems engineering.</p> <p><b>Literacy</b> Selection of the appropriate literacies in the realization of a system.</p> <p><b>Capability Engineering</b> An appreciation of the role the system of interest plays in the system of which it is a part.</p> <p><b>General Engineering</b> Fundamental concepts in mathematics, science and engineering and their application.</p> <p><b>Critical Thinking</b> The objective analysis and evaluation of a topic in order to form a judgement.</p> <p><b>Systems Modeling and Analysis</b> Precision of opinion data and information including the use of modeling to support technical understanding and decision making.</p>	<p><b>Communications</b> The dynamic process of transferring or exchanging information.</p> <p><b>Ethics and Professionalism</b> The personal, organizational, and corporate standards of behavior expected of systems engineers.</p> <p><b>Technical Leadership</b> The application of technical knowledge and experience in systems engineering together with appropriate professional competencies.</p> <p><b>Negotiation</b> Dialogue between two or more parties intended to reach a beneficial outcome where difference exist between them.</p> <p><b>Team Dynamics</b> The motivational, psychological factors that influence the direction of a team's behavior and performance.</p> <p><b>Facilitation</b> The art of helping others to deal with a process, solve a problem, or reach a goal without getting directly involved.</p> <p><b>Emotional Intelligence</b> The ability to monitor one's own and others' feelings and use the information to guide thinking and action.</p> <p><b>Coaching and Mentoring</b> Development approaches based on the use of one-to-one conversations to enhance an individual's skills, knowledge or work performance.</p>	<p><b>Planning</b> The ability to perform tasks and manage resources. Systems Engineering associated with the Management Process SE framework.</p> <p><b>Monitoring and Control</b> Predicting, coordinating and monitoring effective and verifiable plans across multiple disciplines.</p> <p><b>Decision Management</b> The structured, analytical framework for identifying, identifying, characterizing and evaluating a set of alternatives.</p> <p><b>Business and Enterprise Integration</b> The consideration of needs and requirements of other internal stakeholders as part of the system development.</p> <p><b>Acquisition and Supply</b> Obtaining or providing a product or service in accordance with requirements.</p> <p><b>Information Management</b> Activities and data associated with all aspects of information, to provide designed distributions with appropriate levels of timeliness, accuracy and security.</p> <p><b>Risk and Opportunity Management</b> Ensuring the overall coherence of system functional performance and physical characteristics throughout its lifecycle.</p> <p><b>Project Management</b> The identification and reduction in the probability of project risks, or maximizing the potential of opportunities provided by them.</p> <p><b>Logistics</b> The support and sustenance of a product once it is transferred to the end user.</p> <p><b>Quality</b> Achieving customer satisfaction through the control of key product characteristics.</p>
<p><b>INTEGRATING COMPETENCIES</b> The competency group recognizes Systems Engineering as an integrating discipline, comprising activities and enabling them to be available in other disciplines to create a coherent whole.</p>	<p><b>Project Management</b> Identification, planning and coordinating activities to deliver a satisfactory system, product, service of appropriate quality.</p> <p><b>Finance</b> Estimating and tracking costs associated with the project.</p>	<p><b>Quality</b> Achieving customer satisfaction through the control of key product characteristics.</p>

# › **WORKSHOP BREAK-OUT TOPICS**

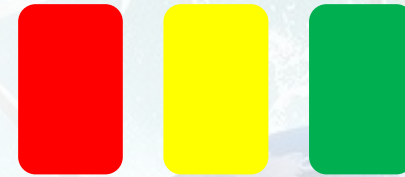
## **BUILDING AND UPGRADING LARGE QUANTITIES OF MID AND HIGH-VOLTAGE STATIONS**

- 1. Where, and in what role, can SE have the most impact on accelerating the energy transition, for design and construction of stations, e.g:**
  - › Improve predictability of projects and quality of systems (stations)
  - › Accelerate building of stations,
  - › Improve collaboration / outsourcing
  - › Foster innovation
- 2. Which SE methodologies are most valuable for the energy transition and why?**
  - › Which problems will it solve, in particular for design and construction of stations?
  - › What is a success story in your own domain; how to transfer that to the energy domain?
- 3. What are the biggest challenges for deploying SE in this sector?**
  - › What are your lessons learned / advices to pass on to the energy sector for deploying SE?

# WORKSHOP PROGRAMME

## BUILDING AND UPGRADING LARGE QUANTITIES OF MID AND HIGH-VOLTAGE STATIONS

- **Select your topic/break-out group** by taking a card



- **Discuss in break-out groups** with moderator:

15:30 – 16:00 hrs

- **Plenary report out:** share key insights:

› 10 minutes per group

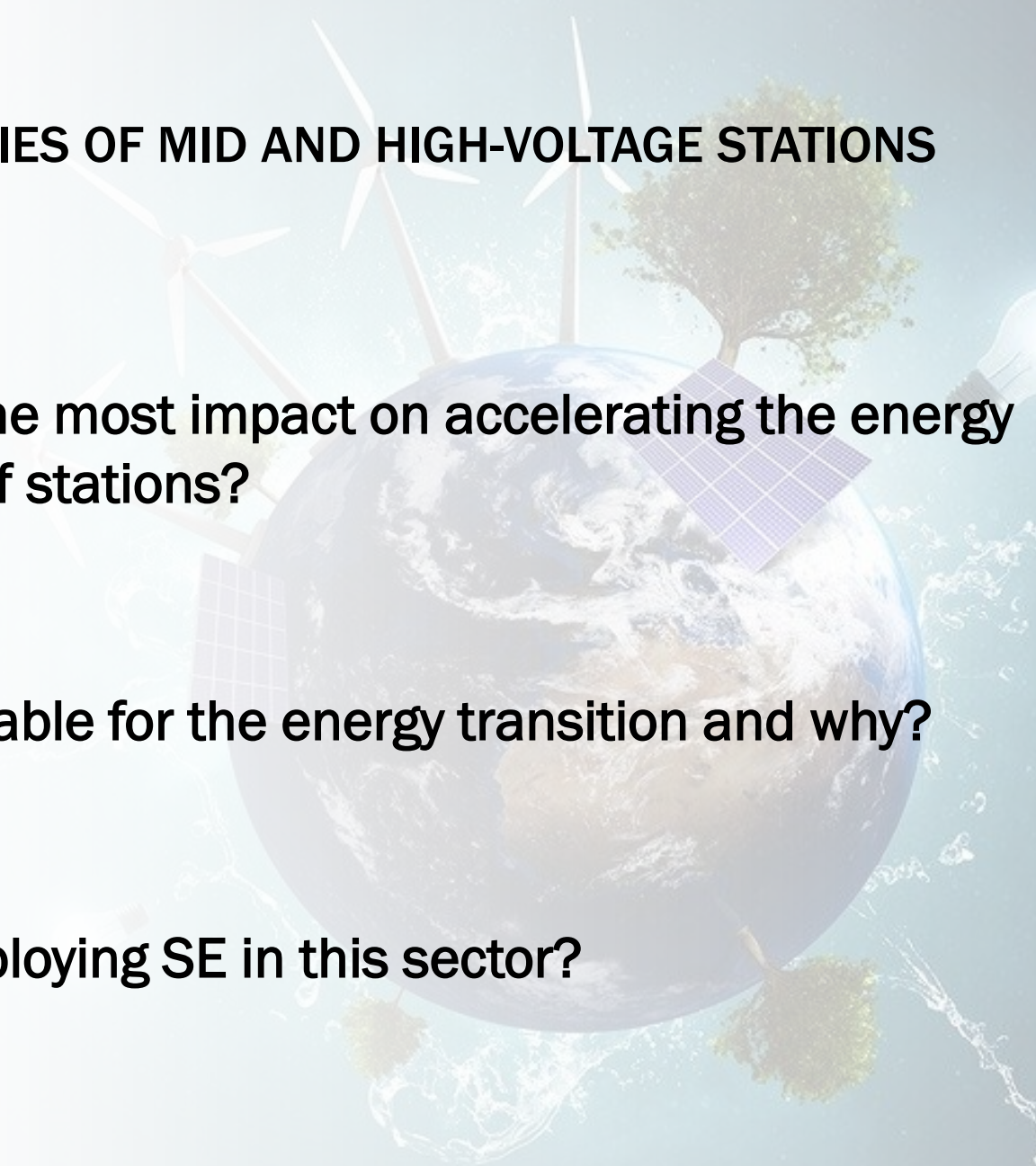
16:00 – 16:30 hrs

➔ **Consolidation report** in INCOSE SIG Energy:

be welcome, next session 18 Oct!

## › **WORKSHOP BREAKOUTS**

### **BUILDING AND UPGRADING LARGE QUANTITIES OF MID AND HIGH-VOLTAGE STATIONS**

- 
- 1. Where, and in what role, can SE have the most impact on accelerating the energy transition, for design and construction of stations?**
  - 2. Which SE methodologies are most valuable for the energy transition and why?**
  - 3. What are the biggest challenges for deploying SE in this sector?**

# › **WORKSHOP REPORT OUT**

## **BUILDING AND UPGRADING LARGE QUANTITIES OF MID AND HIGH-VOLTAGE STATIONS**

### **1. Break-out 1 findings and insights**

- › Where, and in what role, can SE have the most impact on accelerating the energy transition, for design and construction of stations?

### **2. Break-out 2 findings and insights**

- › Which SE methodologies are most valuable for the energy transition and why?

### **3. Break-out 3 findings and insights**

- › What are the biggest challenges for deploying SE in this sector?

# WRAP-UP: TRENDS AND NEEDS IN THE ENERGY TRANSITION

## PERSPECTIVE OF GRID OPERATORS

### Trends and drivers

1. Electricity demand increases manifold

2. Rise of sustainable, yet intermittent energy sources

3. Scarcity of public space

4. Increasing political and legislative pressure

5. Digitalization & AI

6. Further integration of energy system(s)

7. Globalization of supply chains

8. Scarcity of engineering experts

9. Vulnerability of energy infrastructure

### Grid operator (SE) needs

1. Build faster

2. Steer towards more efficient grid utilization

3. Increase flex capacity

4. Scale up asset management

5. Grow workforce, skills & productivity

Enablers:

Digitalization of Systems Engineering

SE-competencies for the future

› **THANK YOU FOR YOUR CONTRIBUTIONS!**



Photo by [Matt Jones](#) on [Unsplash](#)

