PAUL SCHERRER INSTITUT

Vinh N. Dang :: Head a.i., Laboratory for Energy Systems Analysis :: Energy Divisions :: PSI

Laboratory for Energy Systems Analysis (LEA)

Lab introduction EPFL/ETHZ Nuclear Engineering MS
MS thesis topic for 2021/2022

May 17, 2021

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Laboratory for Energy Systems Analysis (LEA), Energy Divisions (NES|ENE)

Nuclear Energy and Safety (NES)		Energy and Environment (ENE)
Laboratory for Energy Systems Analysis (LEA) V.N. Dang a.i.		
Technology Assessment (TA) P. Burgherr 	**Energy Economics (EE)** T. Kober 	**Risk & Human Reliability (RHR)** V.N. Dang 
• Energy technologies, energy chains, energy systems • Current and future technology, for electricity, heating, mobility • Environmental (including risks), economic, and socially relevant factors • Critical infrastructure	• Energy scenarios – Potential energy system futures • Energy system models: co-evolution of energy production, conversion, transmission & distribution, and end-use • Modelling of energy markets	• Probabilistic safety assessment • Human factors in system safety • Nuclear power plants & other domains • The human element in critical infrastructure resilience

All major current and future **energy supply** and **energy demand** technologies

contacts: peter.burgherr@psi.ch, tom.kober@psi.ch, vinh.dang@psi.ch

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Technology Assessment:
Greenhouse Gas Emissions – passenger transport

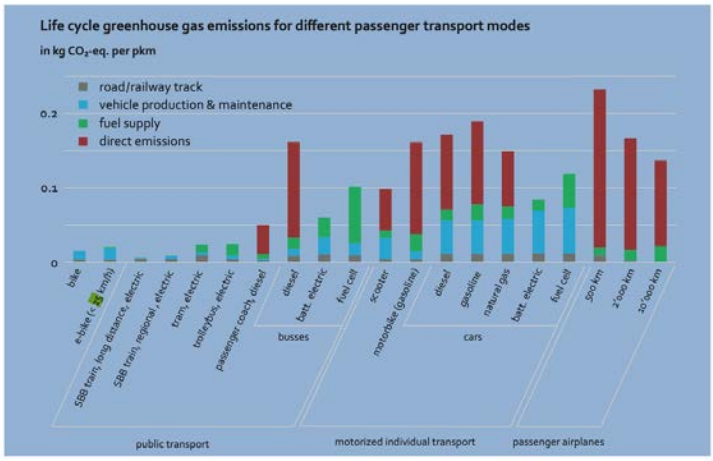


Figure 3. Comparison of current passenger transport modes. Greenhouse gas emissions based on life cycle assessment under the following assumptions: average number of passengers for all vehicles; CH average current electricity consumption mix for battery charging and hydrogen production (Wernet et al. 2016; Cox et al. 2018, 2020a; Sacchi et al. 2020a).

Source: SCCER Mobility White Paper, March 2021

World Energy Scenarios 2019

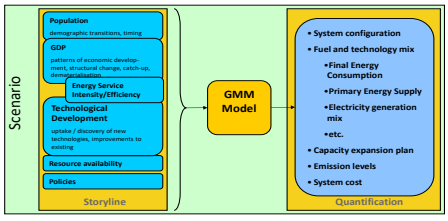
- WEC partnership with PSI and Accenture
- **3 scenarios** with regional-socioeconomic factors

Modern Jazz (market oriented)
- Market chooses technologies
- Tech innovation & digitalisation
- Energy access for all

Hard Rock (fragmented policies)
- Low global cooperation
- Focus on energy security
- Best fit local solutions

Unfinished Symphony (regulation oriented)
- Strong policies focusing on sustainability
- Unified climate action
- Targeted support for technologies

- **Analytical tool for quantification**: PSI's energy system model **GMM**
  - Cost optimal model with resources, energy flows, energy technologies and demand sectors in 17 regions



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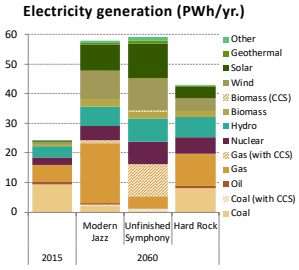
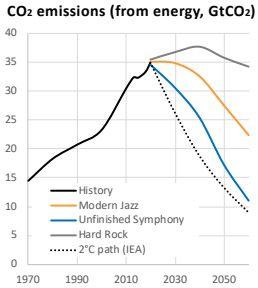
Energy demand and supply mix





- Low-carbon electricity:
- 34% in 2015
  → 2060
  60% *modern jazz* : market-driven
  93% *unfinished symph* : coord., strong policies
  55% *hard rock* : low cooperation

- Jazz on a +2.5ºC pathway
- Symphony slightly above +2ºC
- Hard Rock heads towards +3ºC

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Nuclear Master's presentation, 2021-05 V.N. Dang, Laboratory for Energy Systems Analysis, Energy Divisions

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Research in PSA/HRA

PSA Probabilistic Safety Assessment
HRA Human Reliability Analysis

- HRA methods related to decision-making / errors of commission
  – quantitative use of very small sample data
  – integration and formal treatment of expert judgment
- HRA data collection in simulators
  – methods designed for validation
- HRA for external events, for accident management (severe accident)
- *Human Reliability and Human Performance in other domains*
- Probabilistic modeling : stochastic processes (dynamics & outcomes)

Nuclear Master's presentation, 2021-05 V.N. Dang, Laboratory for Energy Systems Analysis, Energy Divisions

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Control Room Staffing

Representative control room crew, PWR or BWR
- Shift supervisor
- Senior Reactor Operator
- Reactor operators
- Shift technical advisor

Control room staffing, minimum levels (USA, 10 CFR 50.54(m))

1 operating unit 1 CR	2 oper. units 1 CR	4-6 modules 1 CR
2 SRO, 2 RO	2 SRO, 3 RO	

2021/2022 Semester, MS project topics
LEA Risk and Human Reliability

Stochastic simulation, probabilistic modeling
A Human Performance Model for Modular Reactor Operations

Semester project: become familiar with the requirements on control room staffing and their application to small modular reactors. Develop a stochastic crew response simulation that considers variability in performance times and outcomes.

Master thesis: To examine the impact of alternative staffing schemes, a probabilistic model of the crew actions will be derived. It will be implemented to compare performance in selected scenarios modeled with the plant-crew response simulation.

LEA Risk & Human Reliability
Contact: Miltos.Kyriakidis@psi.ch, Vinh.Dang@psi.ch

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2021/2022 MS topic
LEA Risk and Human Reliability &
LES Laboratory for Waste Management

Uncertainty analysis in risk and performance assessments

"Sorption competition parameter uncertainty for reactive transport modelling of Ni diffusion through bentonite"

LEA Risk & Human Reliability
Contact: **Luca.Podofillini@psi.ch, Vinh.Dang@psi.ch**

Laboratory for Waste Management (LES)
Wilfried.Pfingsten@psi.ch

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Wir schaffen Wissen – heute für morgen

Thank you for your attention!

Laboratory for Energy Systems Analysis (LEA)

http://www.psi.ch/lea

vinh.dang@psi.ch

Dr. Peter Burgherr
Technology Assessment

Dr. Tom Kober
Energy Economics

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