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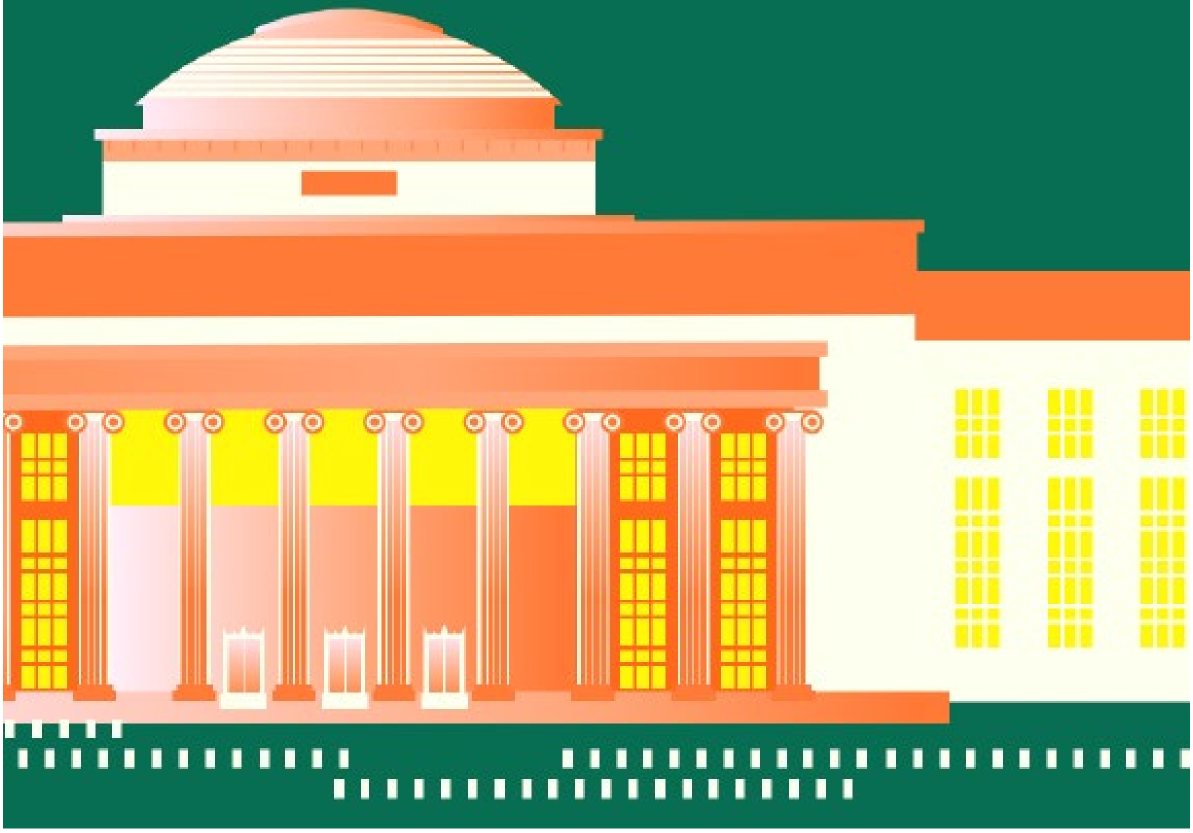
International Conference on Applied Energy

Applied Energy Symposium
MIT A+B

Co-organized with Harvard

AUG 11-13, 2021 · MIT, Boston, USA



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Welcome to the Applied Energy Symposium： MIT A+B.

The IPCC report "Global Warming of 1.5°C" (Oct. 2018) issued a dire warning that unless CO2 emissions are halved by 2030, devastating changes, which will be sooner than expected and irreversible, will occur in ocean and on land. Time is running out for transitioning to new energy systems globally. Logic and numbers show that the world must take a two-step approach: (A) deploy existing, industrially proven technologies, namely solar, wind and nuclear base load at an unprecedented scale and pace, from now to 2050 – when a house catches fire, firemen must run to the closest hydrants and stop disputing which water stream would be purer; and (B) develop new concepts and technologies that may replace the dirtier parts of (A) post-2050, at terawatt scale.

The Applied Energy Symposium: MIT "A+B" (MITAB) is dedicated to the accelerated deployment of (A), and new concepts and emerging technologies for (B). For (A), reducing capital and operating costs, managing social dynamics, and minimizing environmental impact while maintaining extreme productivity are key; automation, artificial intelligence, social mobilization, governmental actions and international coordination will provide essential boosts. For (B), we seek new concepts and emerging technologies (e.g. fusion power engineering, superconducting transmission, etc.) that stand a chance to scale to terawatts after 30 years, i.e. "baby technologies" can grow to adulthood in 20-30 years.

MITAB 2021 consists of a three-day symposium on August 11-13, 2021, virtually. All presentations (with the author's permission) will be video recorded and posted on YouTube or other open sources for public dissemination. Outstanding presentations will be recommended by the session chair and scientific committee to be further considered for publication in a special issue of Applied Energy (journal Impact Factor 8.8, please find more information at https://www.journals.elsevier.com/applied-energy). .

To be invited to present at this symposium, please upload one of the following: a .zip file (<20MB) containing a video or voice file (≤10 min), or a Powerpoint presentation (≤20 slides), or an abstract (≤2 pages) or a conference paper (≤6 pages), which explain how and why your work matters to A or B. The manuscript will be reviewed by symposium organizers for acceptance to the conference. Examples of topics include, but are not limited to, the following:

- Renewable energy: solar energy (A or B), wind energy (A), bioenergy (A or B), and other renewables.
- Clean energy conversion technologies: fuel cells and electrolyzers (A or B), conversion of petroleum/gas/coal to high-valued materials and chemicals (A), hybrid energy systems, such as the combination of intermittent renewable energies and nuclear heat storage for load following, chemicals/materials/fuel production (A or B), multi-energy carrier energy systems (A or B).
- Energy storage: grid-scale batteries (A), battery management systems (A), fuel cell/ electrolyzer management systems (A), pumped hydro/compressed air (A), thermal energy storage (A or B), distributed energy storage (A).
- Nuclear energy: innovative concrete solutions and civil constructions (A), application of robotics and AI (A), shipyard constructed floating reactors (A), small modular reactors and micro-reactors (A or B), fast neutron reactors (B), fusion reactors (B).
- Mitigation technologies: Carbon capture and sequestration (B), nuclear waste (A), solar waste (A), battery waste (A), reduced-CO2 production of cement, bulk metals and chemicals (A or B).
- Intelligent energy systems: smart grids (A), ultra-efficient/superconducting power transmission (B), wireless power transmission (B); electrification of transportation and industrial production, such as electric cars/trucks (A or B), electrified air flight (A or B), microwave/plasma/electrochemical processing (A or B).
- Sustainability of energy systems: Environmental monitoring (A), social mobilization (A), consensus building (A), governmental policy making (A), international coordination (A).
- Sustainable geoenergy: geothermal (A or B), gas hydrate (A), unconventional natural gas (A), LNG, reducing methane and CO2 emission (A) of oil and gas sector, sustainable geoenergy development and management (A).
- Food, water and air: water and air treatment (A), reduced-CO2 production of food (A), Water-Food-Energy Nexus (A).

Given the grave urgency of our mission, we ask authors to be earnest, practical and in a problem-solving mode in their presentations. Creativity will be highly valued.

Details and updated information are available at www.applied-energy.org/mitab2021. If you have questions regarding this conference or submission, please contact Conference Organization Chair Dr. Ray (Zhenhua) Rui at MIT (mitab2021@applied-energy.org).

Program at a Glance

Day 1: Thursday, August 12, 2021 (Boston Time)	
8:00 -8:20	Chair Welcome
8:20-9:10	Electrochemically modulated mitigation of acid gas emissions
9:10-10:00	"Green" energy realpolitik: Challenges in materials sourcing
10:00-10:20	Coffee/Tea Break
10:20-11:10	New directions for fuels from sunlight
11:10-12:00	The critical role of carbon capture and storage in decarbonizing California's energy system
12:05-13:10	Lunch Break
13:10-15:10	Energy Fuel
15:10-15:35	Coffee/Tea Break
15:35-17:35	Sustainability
Day 2: Friday, August 13, 2021 (Boston Time)	
8:00-10:00	Innovation
10:00-10:25	Coffee/Tea Break
10:25-12:25	Energy Materials
12:25-13:10	Lunch Break
13:10-15:10	Decarbonization
15:10-15:35	Coffee/Tea Break
15:35-17:35	Carbon capture, utilization and storage
Pre-recorded 5 Oral Sessions and 2 E-Poster Tracks (Page 11~ Page 18)	

Topic Session

Energy Fuel

13:10-15:10, Thursday, August 12

Prof. Bingqing Wei

University of Delaware

Photocatalytic hydrogen production from water via photothermally induced biphase systems

Prof. Curtis Berlinguette

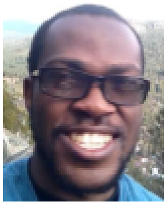
The University of British Colimbia

Converting captured CO2 directly into fuels

Prof. Hans Auer

Technische Universität Wien

Low carbon European energy system scenarios - the open modeling platform developed in openENTRANCE



Session Chair

Dr. Chukwunwike Iloeje

Argonne National Laboratory

Sustainability

15:35-17:35, Thursday, August 12

Dr. Holger Schlör

Institute of Energy and Climate Research

The Food-Energy-Water-Nexus and a Keynes sector in a post growth economy – learnings from a CGE model

Dr. Destenie Nock

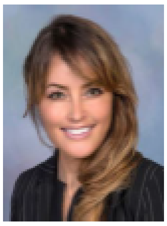
Carnegie Mellon University

Low-carbon energy transitions: a systemic approach to quantifying equality and sustainability trade-offs

Dr. Giovanni Baiocchi

University of Maryland

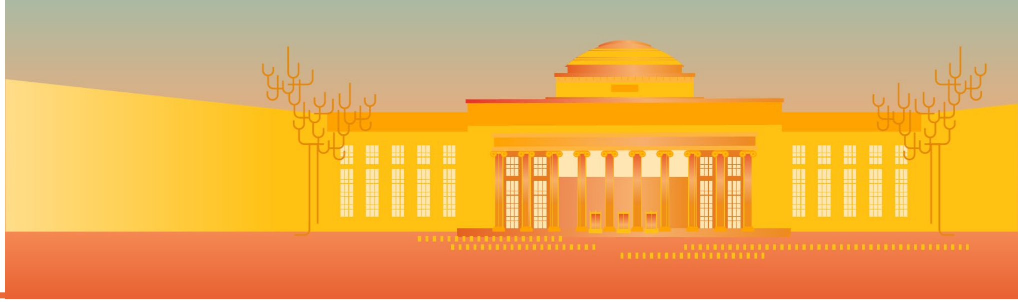
A window of opportunities of sustainable recovery pathways in post-COVID in the U.S.



Session Chair

Dr. Rachel Meidl

Rice University's Baker Institute



Low Carbon European Energy System Scenarios - the open modeling platform developed in openENTRANCE

Hans Auer,* Energy Economics Group (EEG), Technische Universität Wien, Austria
Pedro Crespo del Granado, Norwegian University of Science and Technology (NTNU), Norway
Pao-yu Oei, Karlo Hainsch, Konstantin Löffler, Thorsten Burandt, Technische Universität Berlin, Germany
Daniel Huppmann, International Institute of Applied System Analysis (IIASA), Austria
Ingeborg Grabaak, SINTEF Energy Research, Norway

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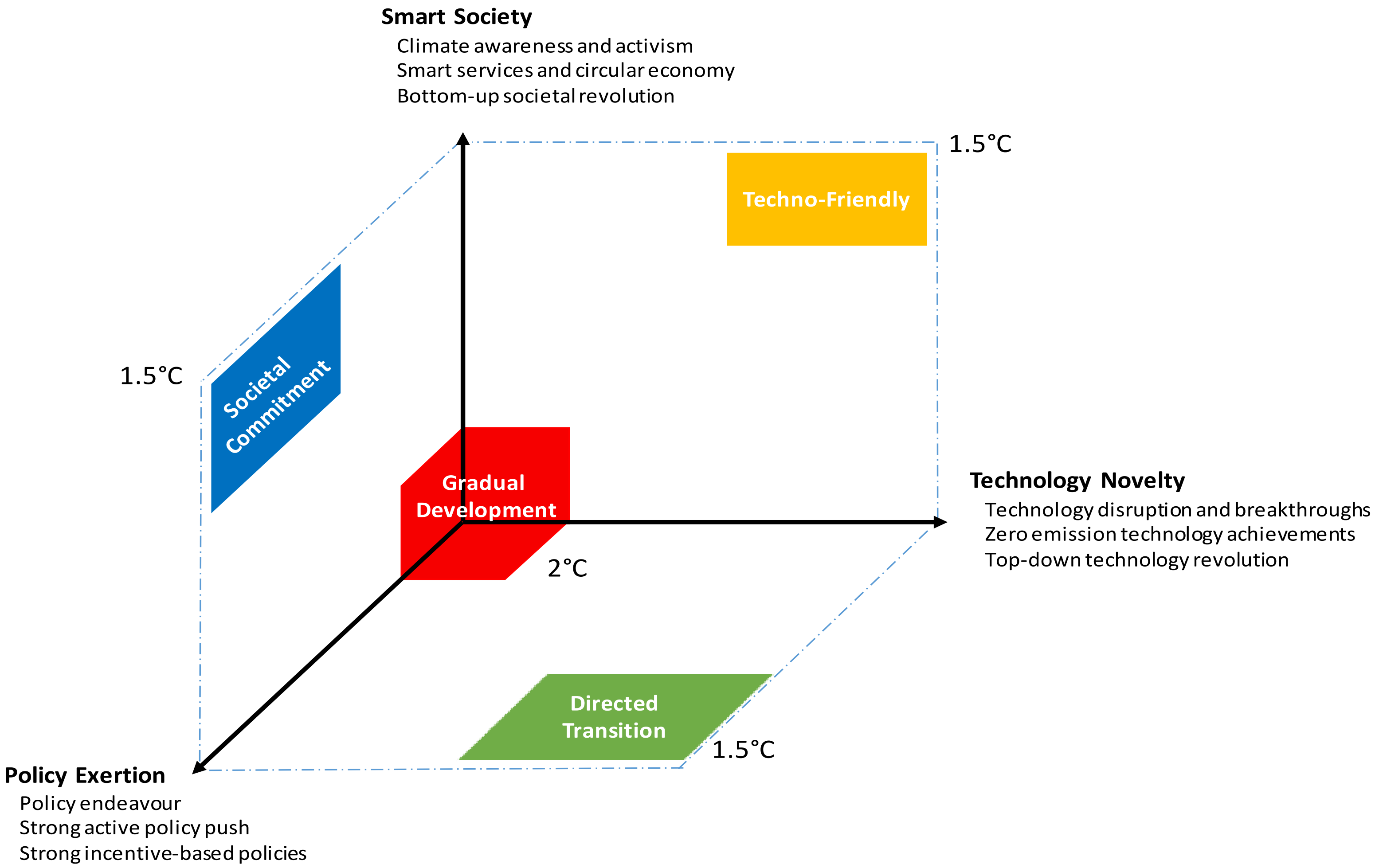
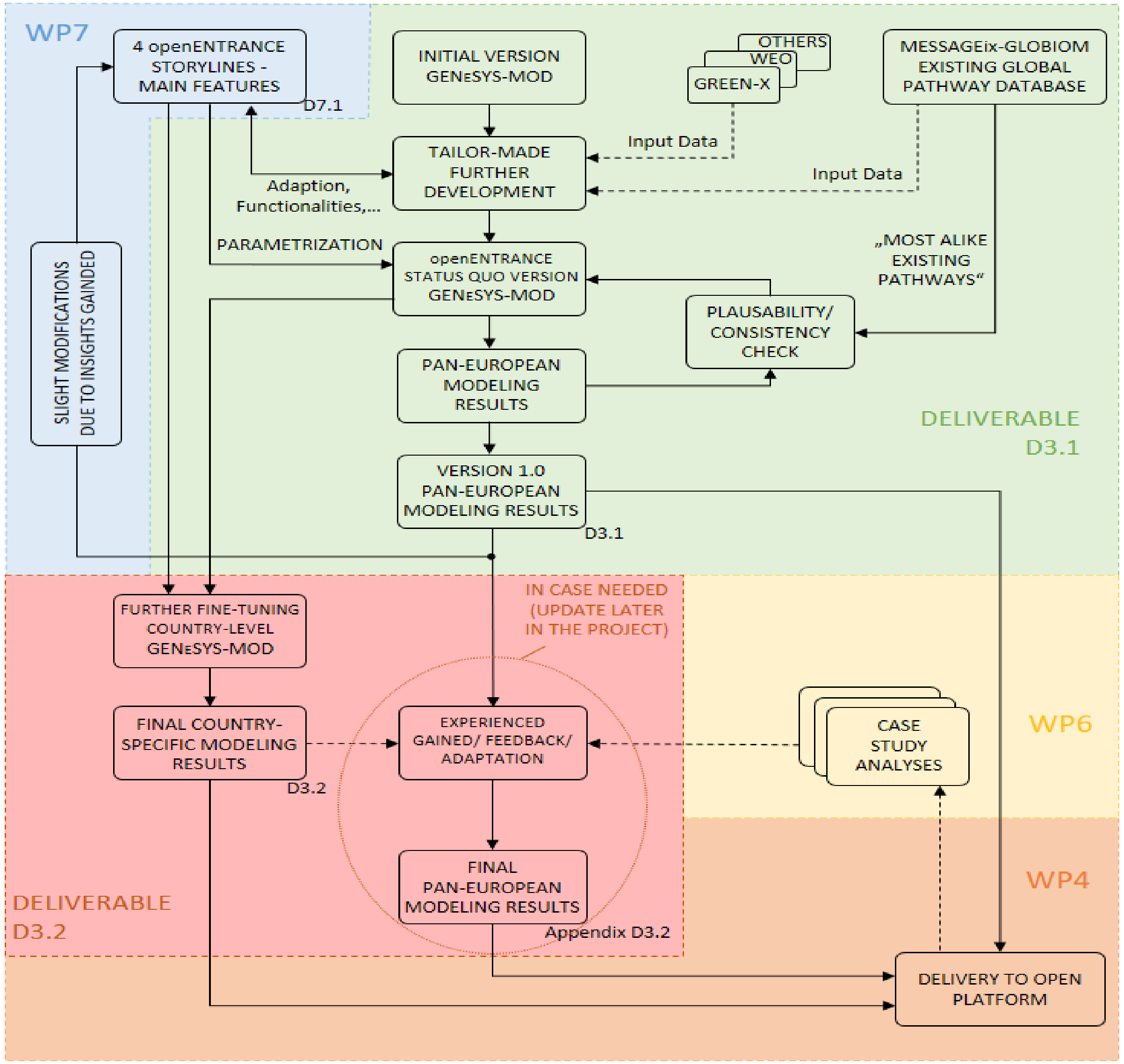
HOW TO UNDERSTAND THE openENTRANCE SCENARIO RESULTS ?

- European Project openENTRANCE: scenarios built upon storylines, see www.openentrance.eu
- Low-carbon scenario studies comply with the (European fraction of) 1.5/2.0°C global warming targets
- Remaining CO_2 budget for Europe (IAM $Message_{ix}$-GLOBIOM) fixes important modeling constraints
- Technology portfolio availability, technology exchange rates (triggered by CO_2 prices) are main determining parameters in the model for achieving carbon neutrality in Europe in 2040 or 2050
- The quantified scenario results not only show the necessities of the optimization model to find feasible solutions from the analytical point-of-view…
- …but also: what needs to be done in the future European energy system if we seriously intend to comply with the 1.5/2.0°C global warming limitation targets
- Our (European) experience/imagination from the past what‘s supposed to be feasible (in terms of speed of technology exchange rates) and/or financable might not be sufficient any more…
- …Business-as-usual (BAU) terminology intentionally has not been used (most expensive) -> outdated
- Open source/data modeling: change of paradigm in energy system modeling: GENeSYS-MOD = Piano (everybody on this globe can play this piano for free and carry out own scenario studies)

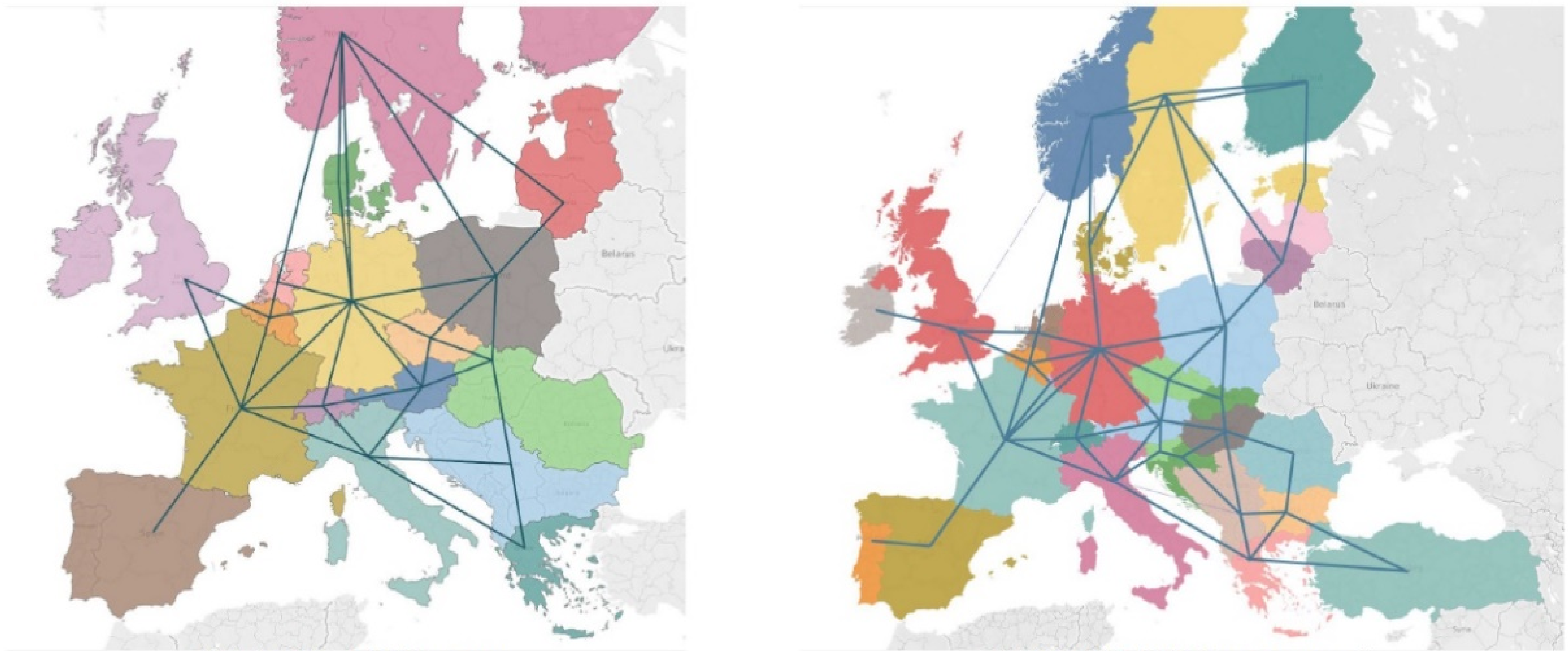
openENTRANCE STORYLINES



FLOWCHART OF MODELING APPROACH



OPEN SOURCE ENERGY SYSTEM MODEL GENeSYS-MOD



GENeSYS-MOD v2.0 GENeSYS-MOD v2.9.0-oE

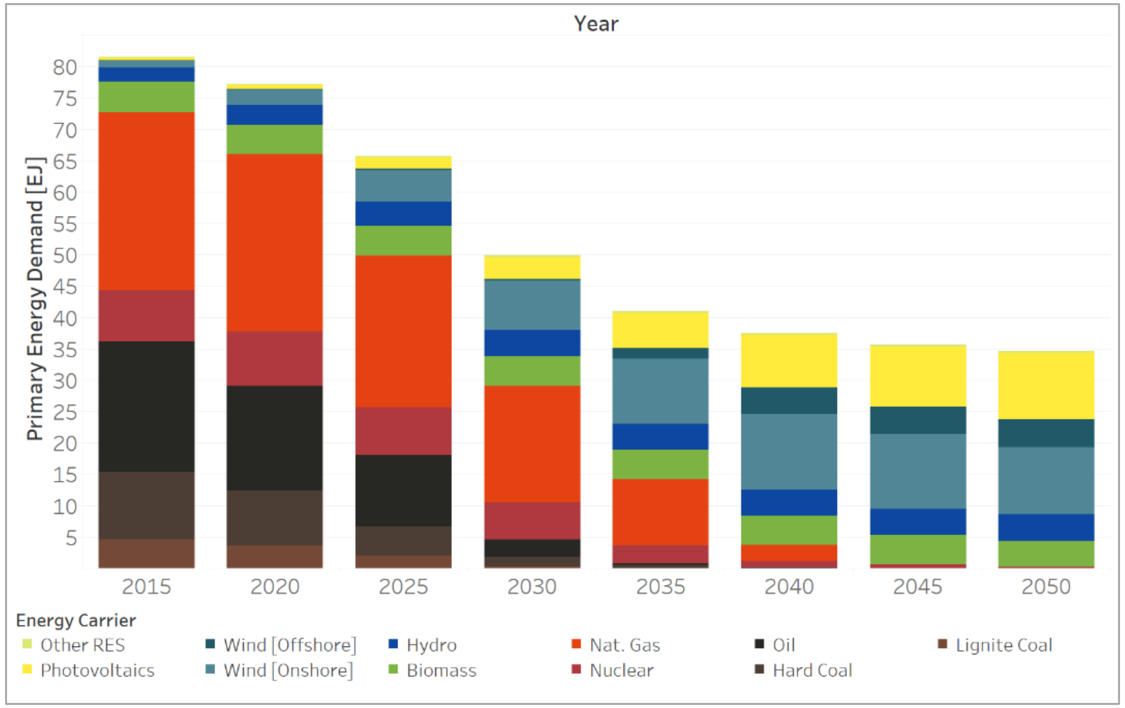
GENeSYS-MOD IMPROVEMENTS/ADAPTATIONS COMPARED TO EARLIER VERSIONS

- Regional update from 17 (partly aggregated) regions to 30+ (EU27, UK, Switzerland, Norway, Turkey, Balkan regions)
- Temporal update: timeslices were replaced by reduced hourly resolution and time-clustering algorithm (all demand and renewable feed-in time series are now on hourly basis)
- More detailed represention of the different sectors, notably industry sector
- Data collection and diaggregation for all new regions (country-spefic input data fine-tuning: ongoing work (!))
- Calibration of the new regions for 2015
- In addition to CO_2 budget contraints also carbon price mechanic

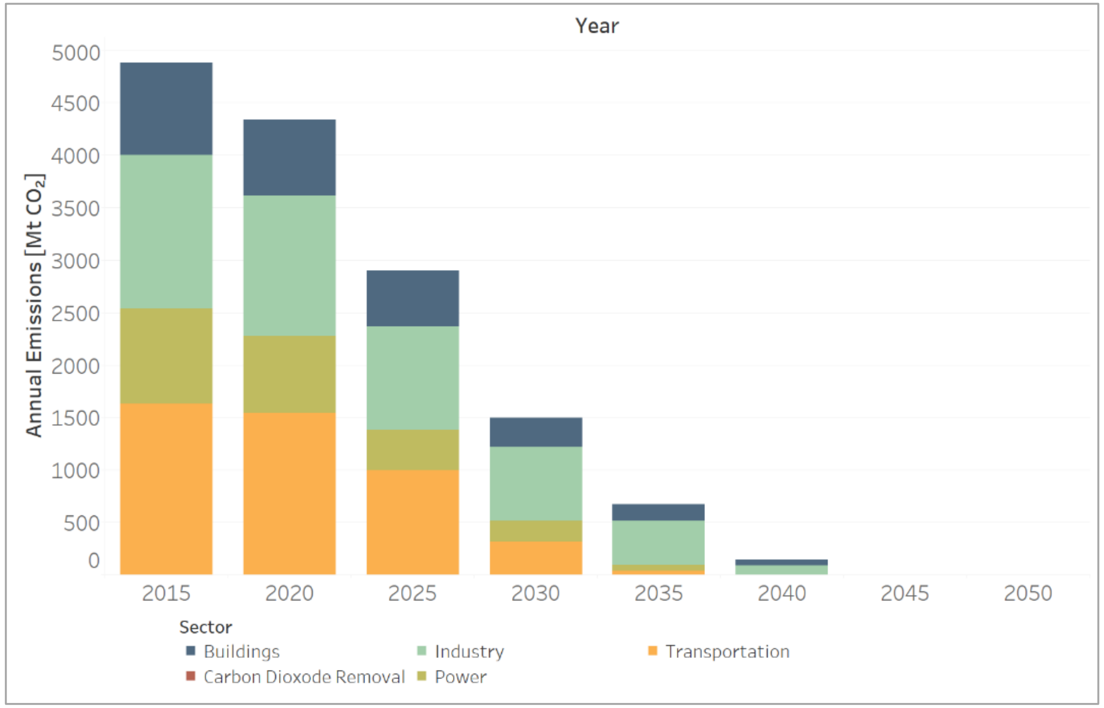
SC, TF, GD: The carbon prices have been created by iterations over different price levels, which in the end ensured carbon neutrality, either in 2040 or 2050 (depending on the scenario).

DT: The carbon prices have been created based on 5 years' CO2 allowances and corresponding technology exchanges of emitting technologies (on the benefit of cleaner ones); trade-off determines (shadow-)price.

SOCIETAL COMMITMENT

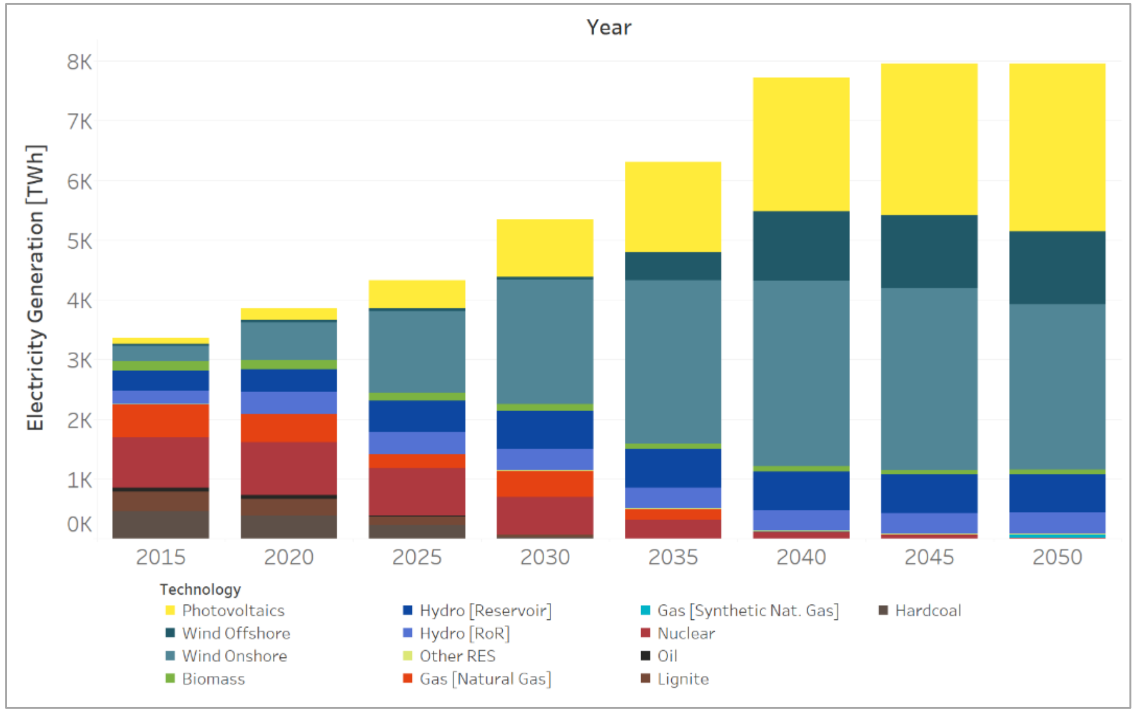


Primary Energy until 2050

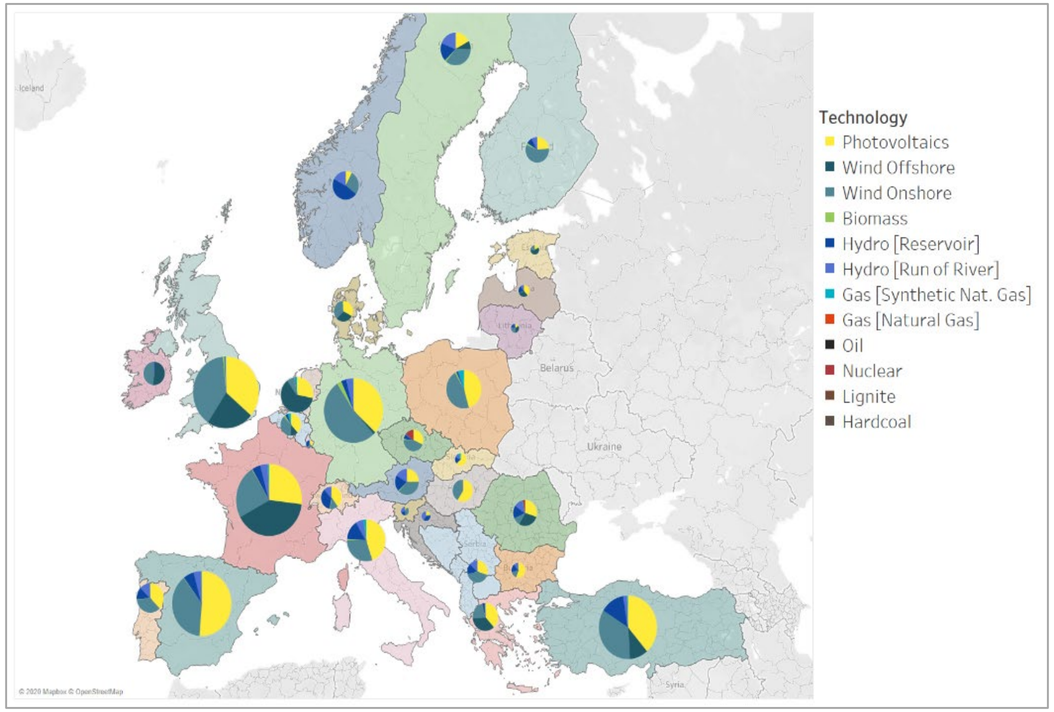


Emissions until 2050

SOCIETAL COMMITMENT

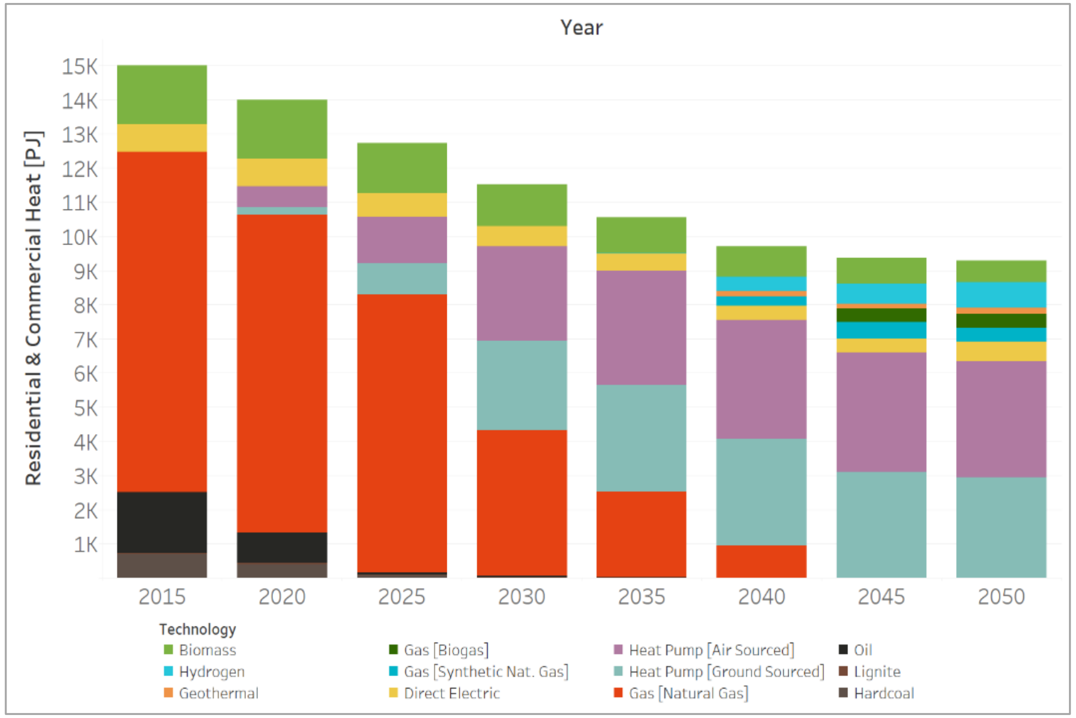


Electricity Generation until 2050

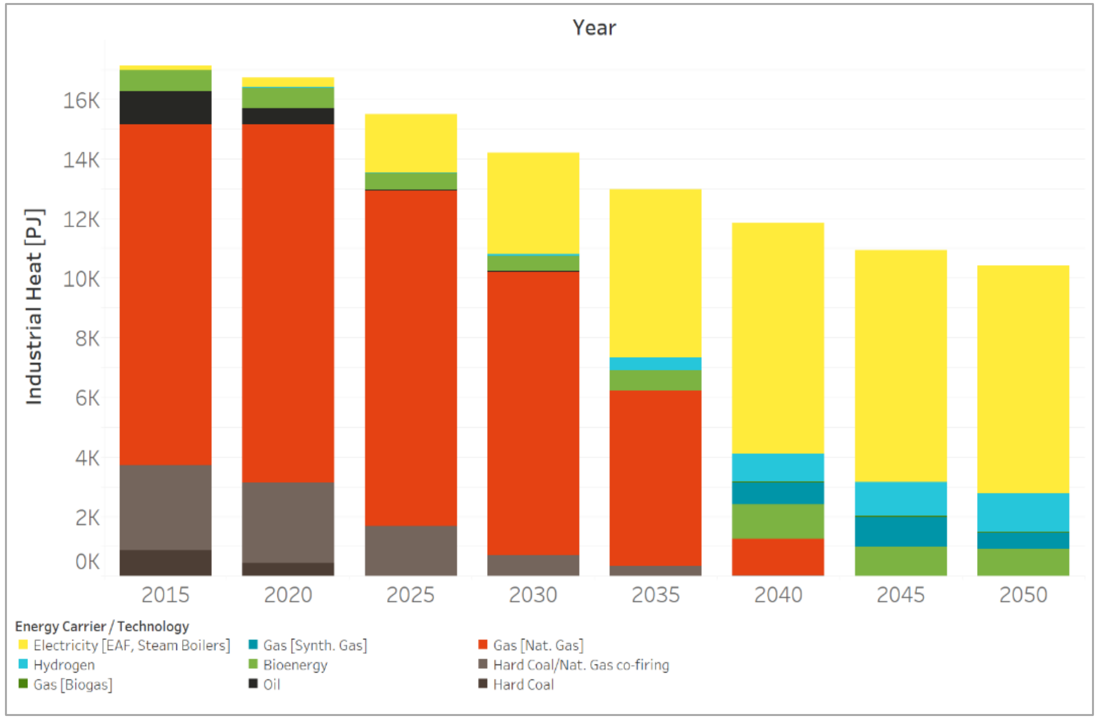


Electricity Generation in 2050

SOCIETAL COMMITMENT

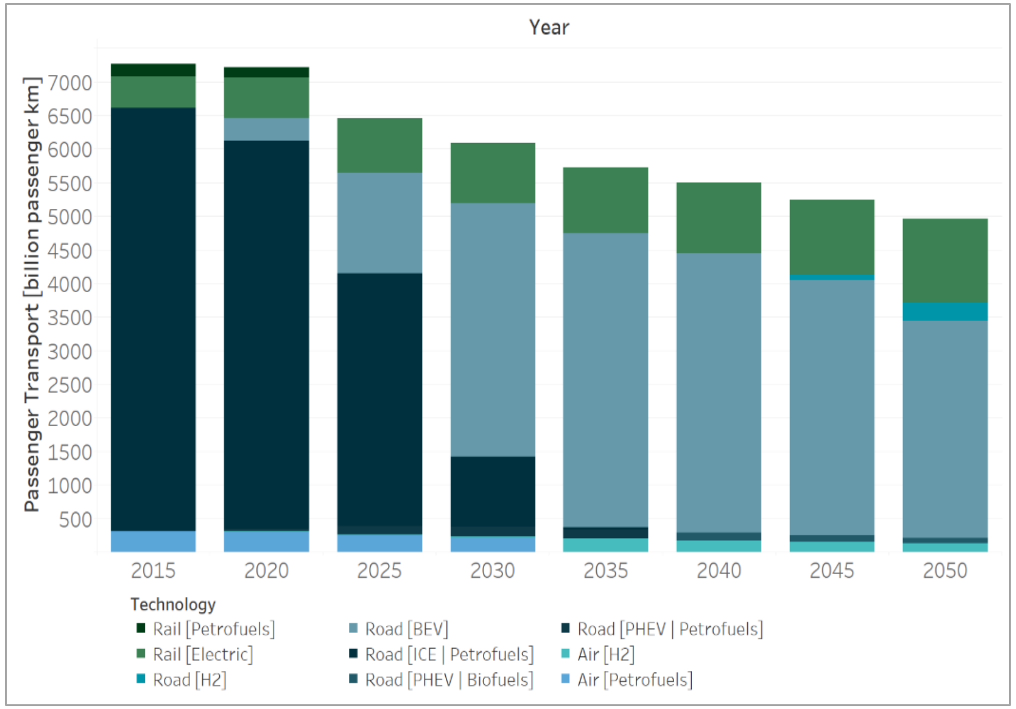


Residential & Commercial Heat until 2050

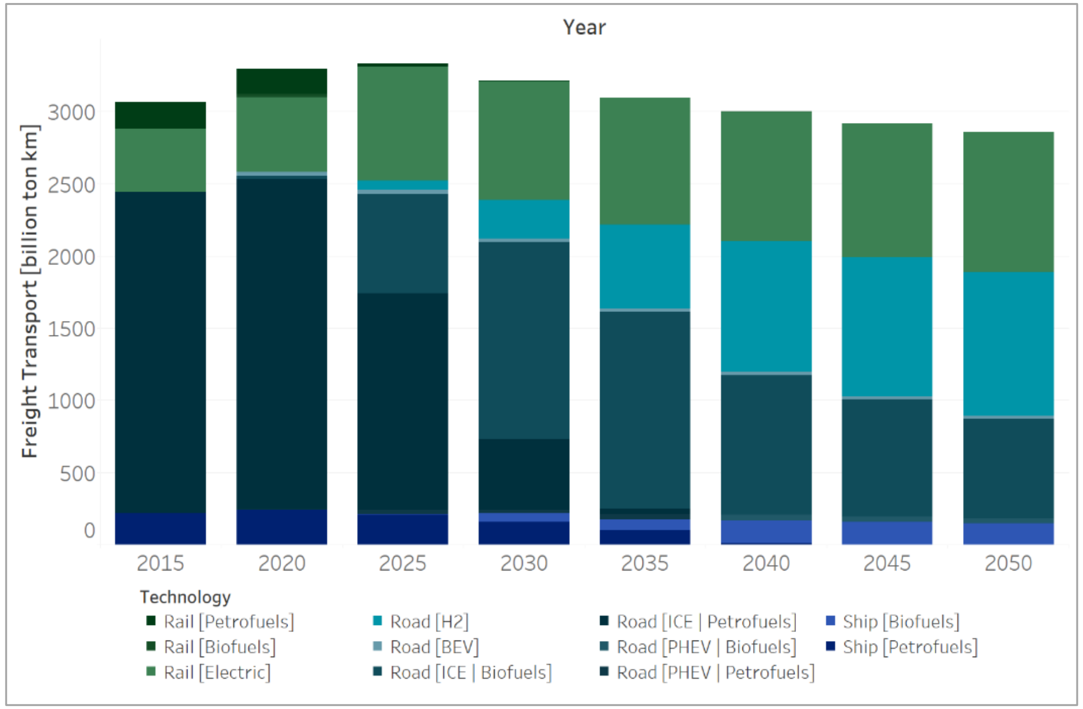


Energy/Technology in Industry until 2050

SOCIETAL COMMITMENT

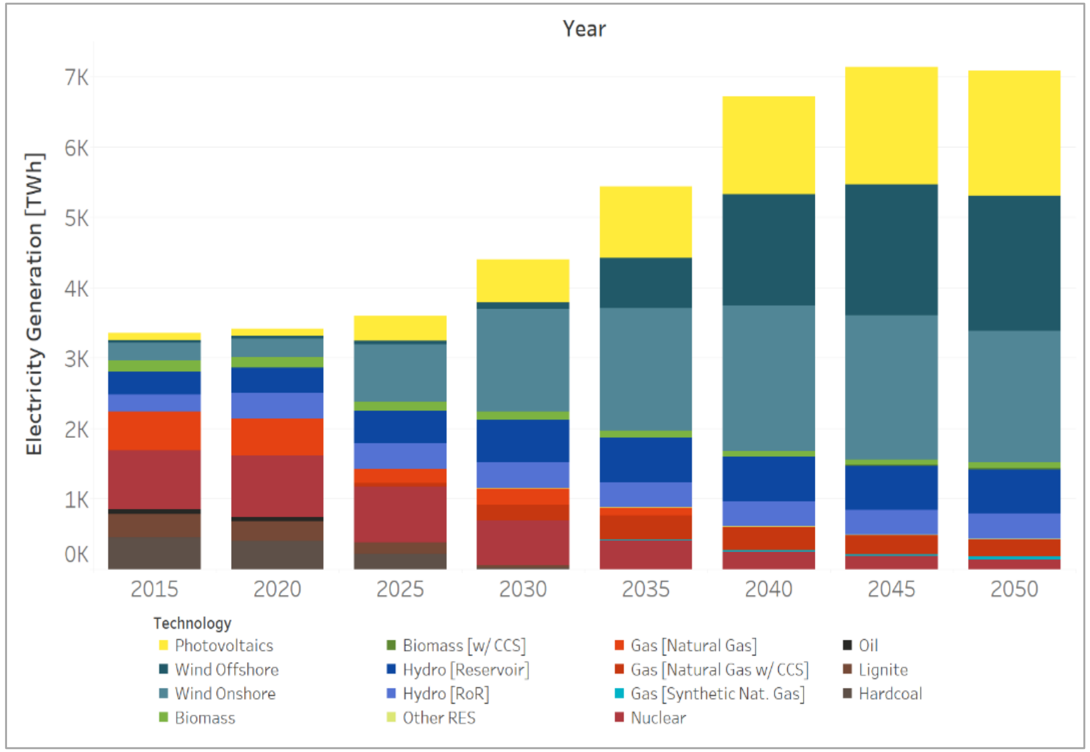


Passenger Transport until 2050

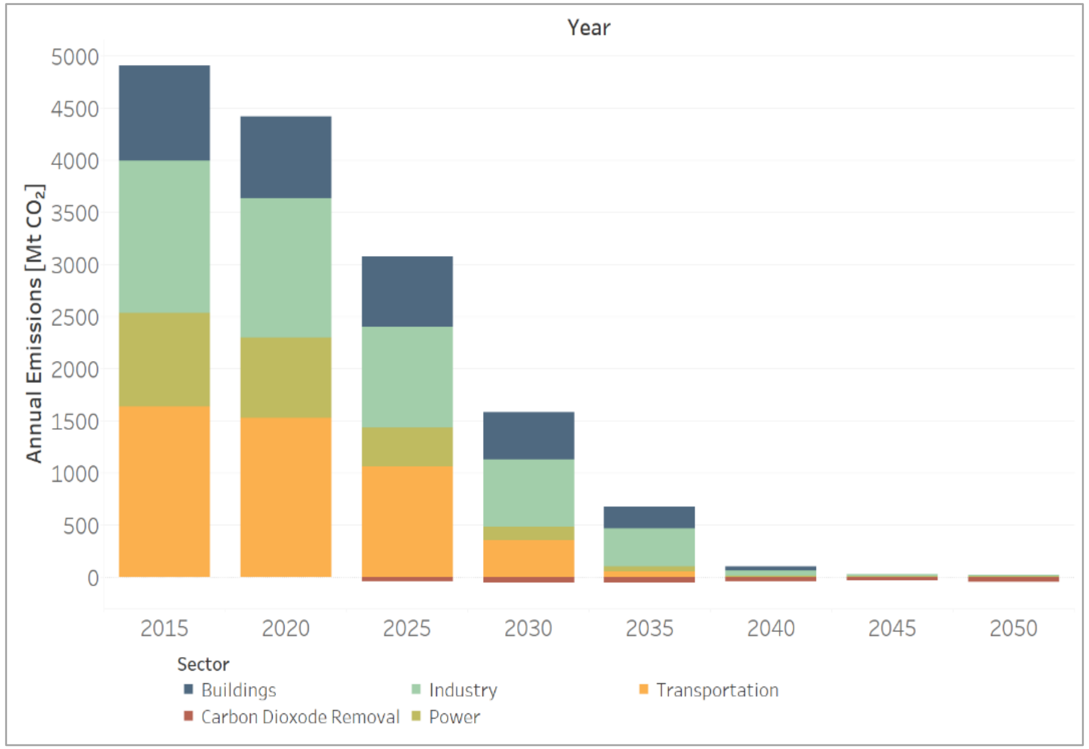


Freight Transport until 2050

TECHNO-FRIENDLY

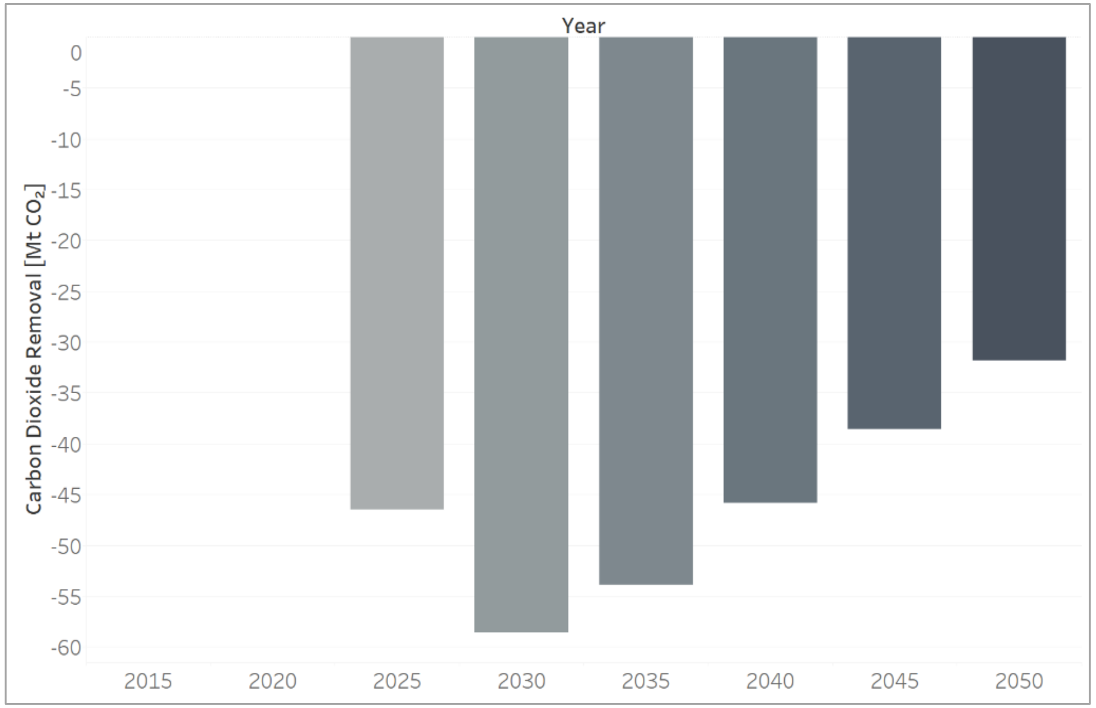


Electricity Generation until 2050

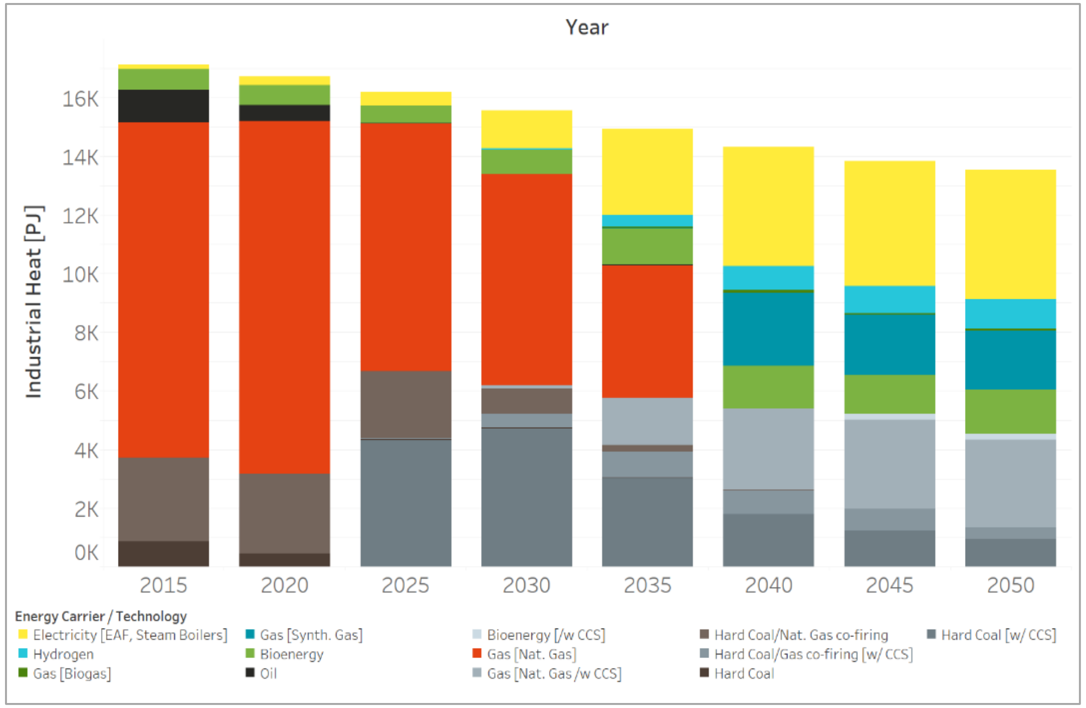


Emissions until 2050

TECHNO-FRIENDLY



CO$_2$ Removal Technologies until 2050



Energy/Technology in Industry until 2050

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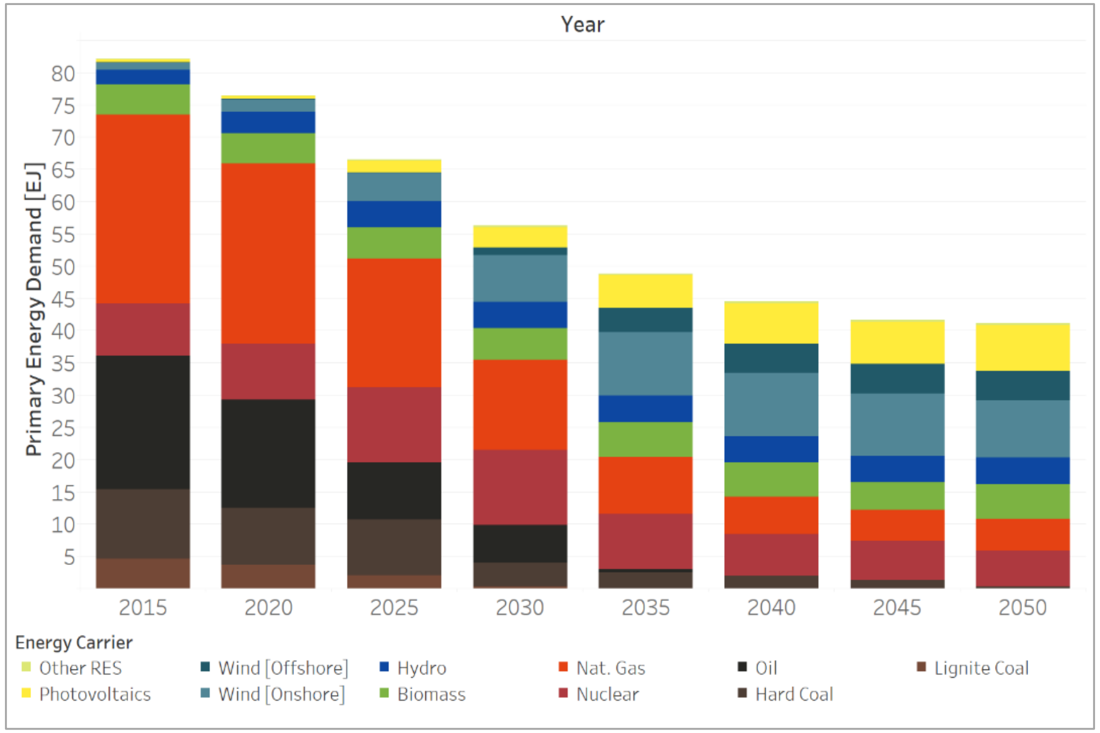
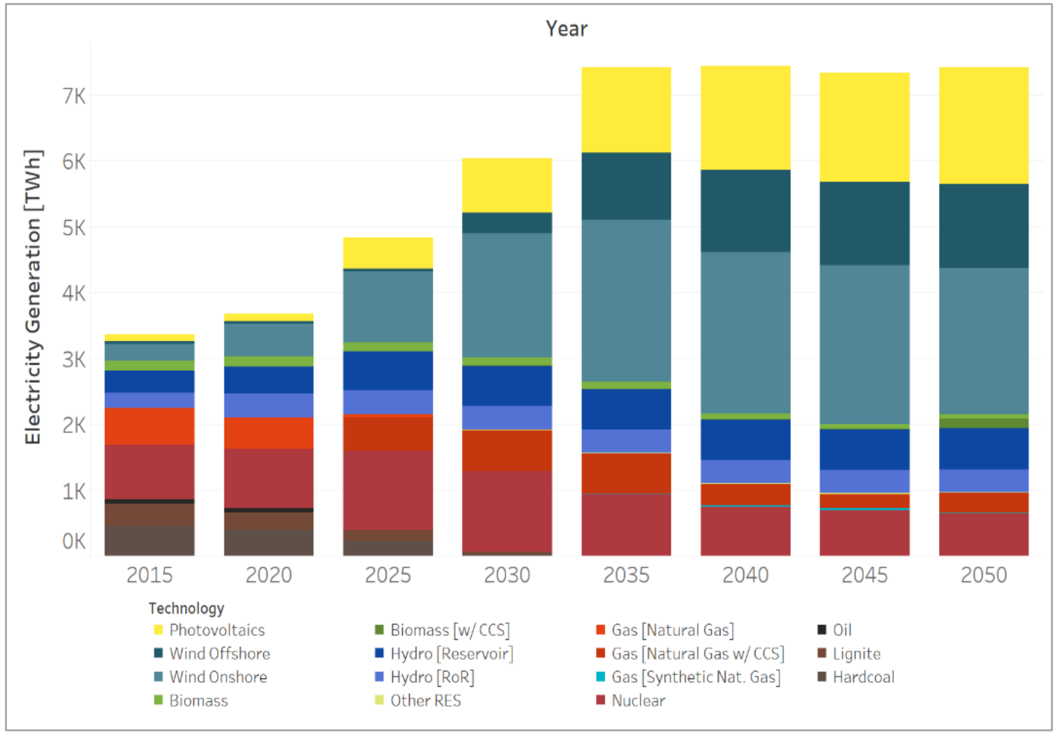
DIRECTED TRANSITION

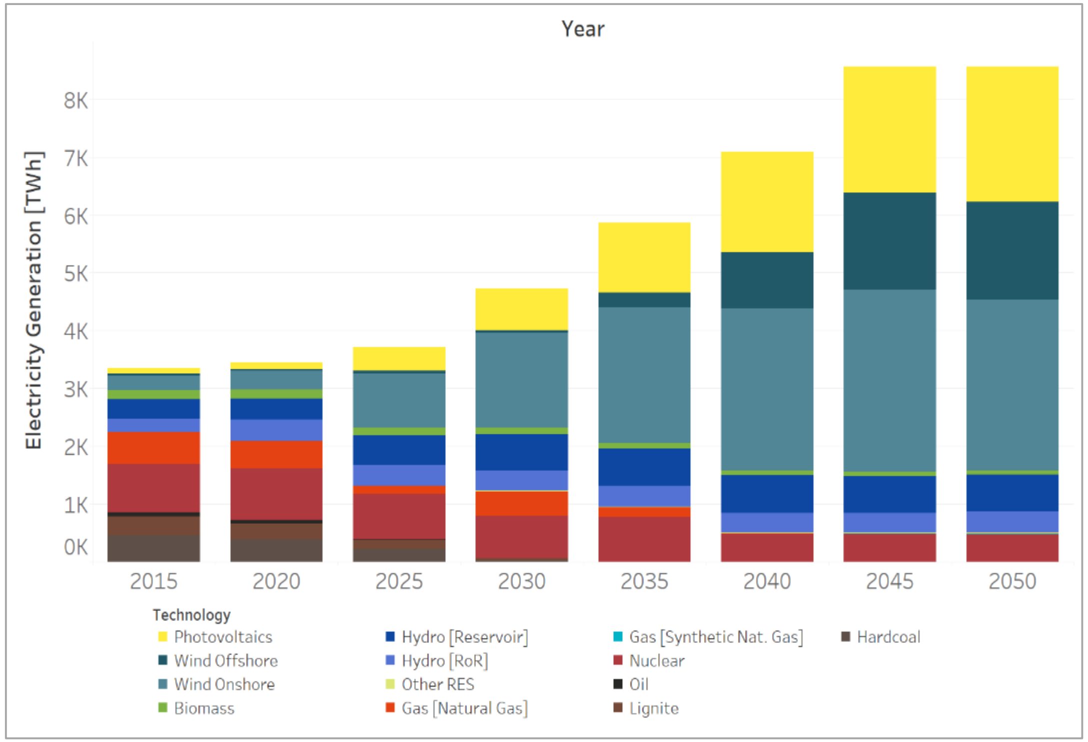


Primary Energy until 2050

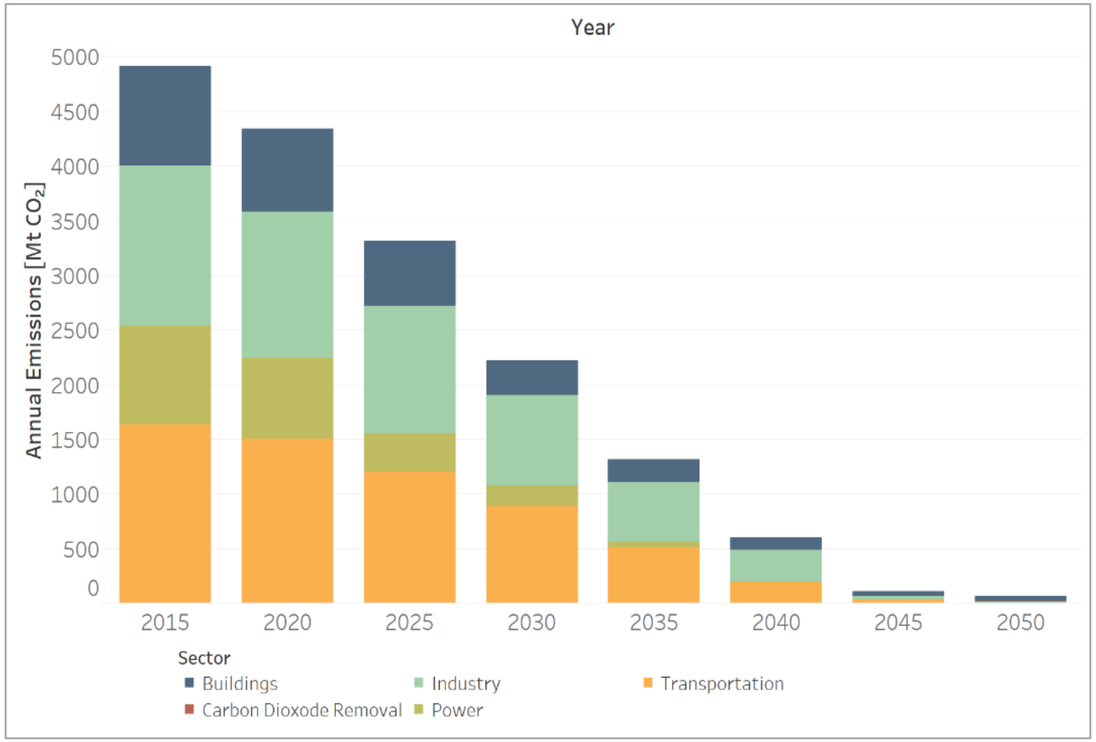


Electricity Generation until 2050

GRADUAL DEVELOPMENT

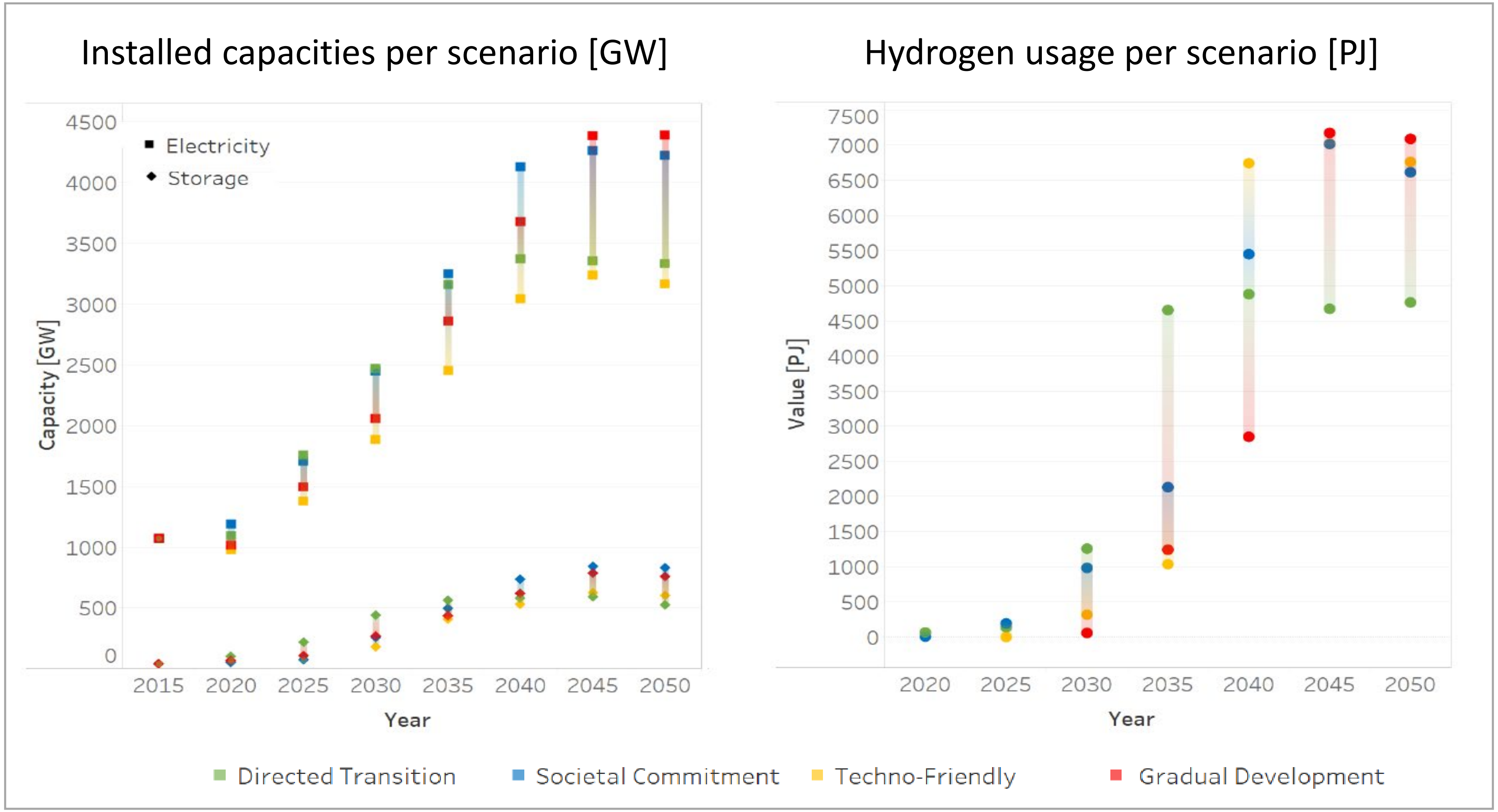


Electricity Generation until 2050

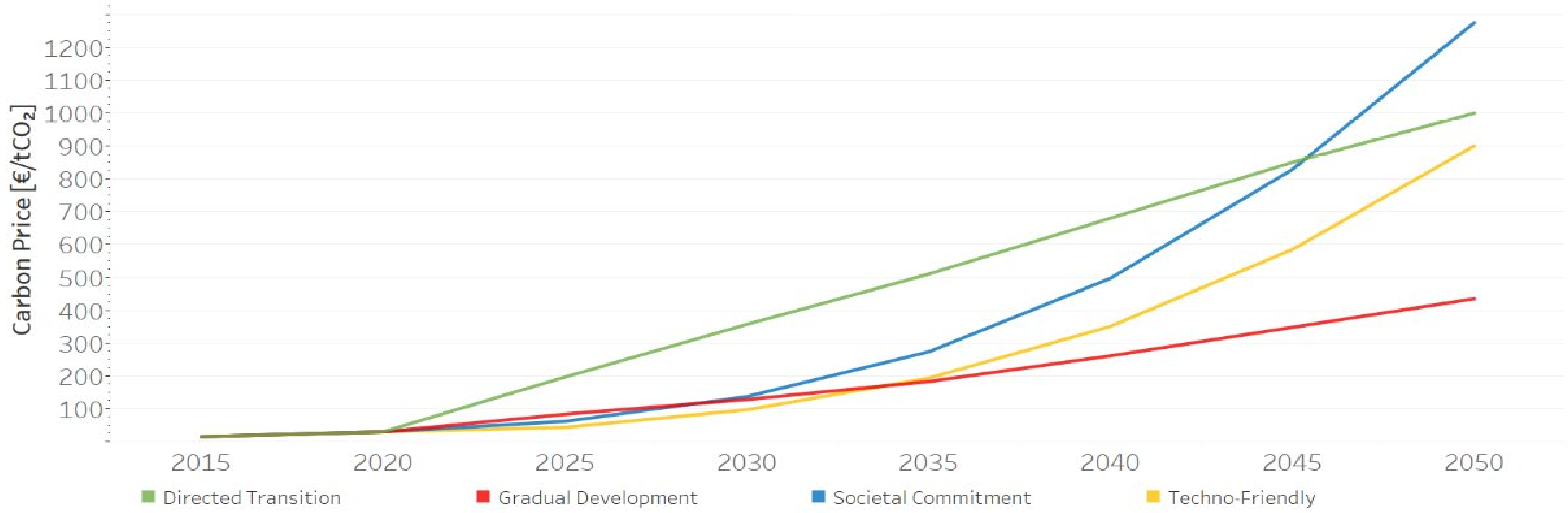


Emissions until 2050

COMPARISON OF KEY INDICATORS FOR ALL FOUR SCENARIOS



CARBON PRICE FOR ALL FOUR SCENARIOS

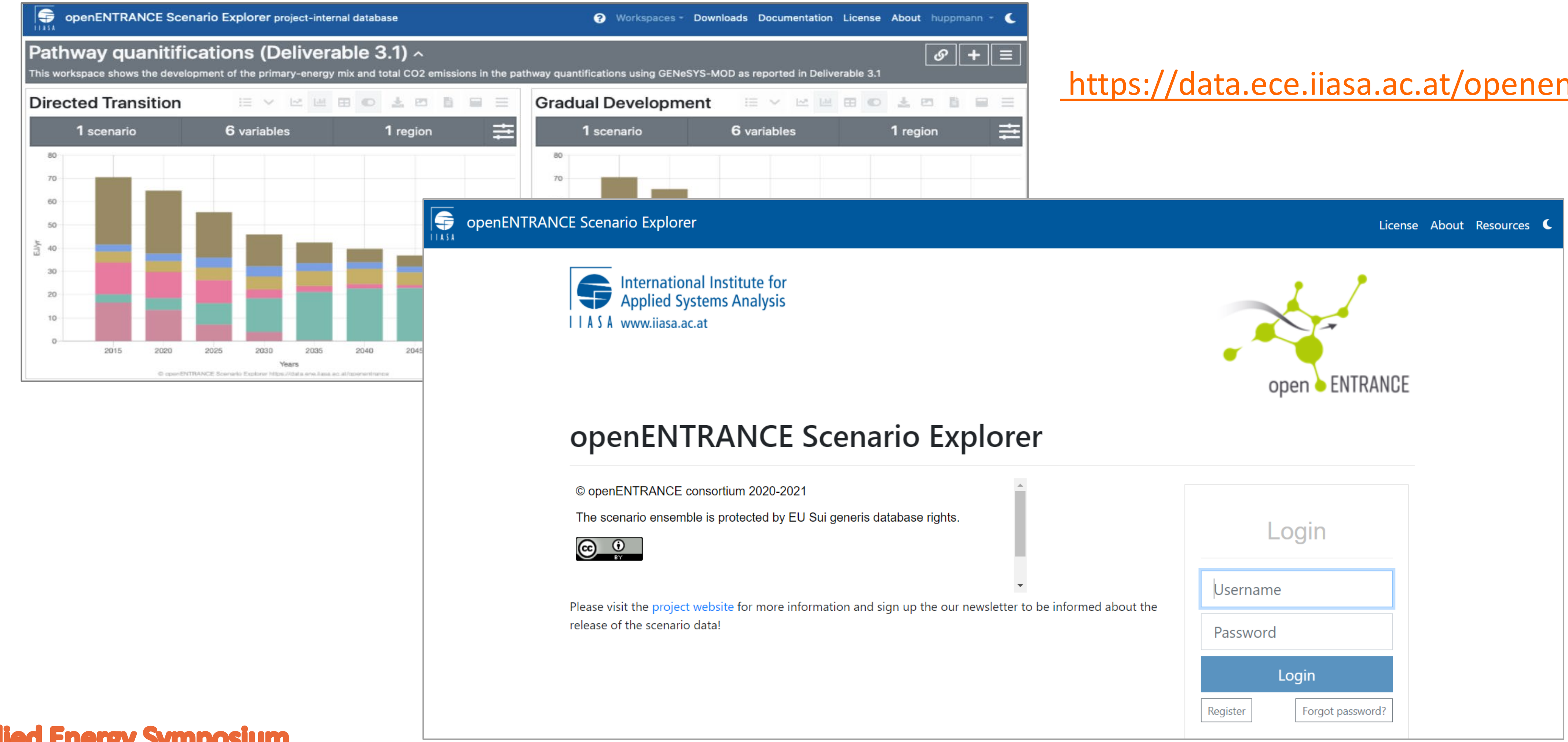


	Year							
Pathway	2015	2020	2025	2030	2035	2040	2045	2050
Directed Transition	15	30	196	357	510	680	850	1,000
Gradual Development	15	30	83	128	183	261	348	435
Societal Commitment	15	30	62	137	273	497	829	1,275
Techno-Friendly	15	30	43	97	193	351	585	900

FINDINGS / INSIGHTS SO FAR …

- If we are going to limit the global temperature increase to 1.5 °C (and in this context conduct our “homework” in Europe), significant efforts need to start now!
- Already in 2030 the emissions in Europe must be around 1/3 of today’s level only!
- This underlines the importance of corresponding policy measures to ease the future energy transition in case of reliance on a less risky strategy *(Directed Transition)*!
- A novel technology breakthrough *(Techno-friendly)* or a fundamental society’s life style change *(Societal Commitment)* also can meet the ambitious goals, but the risk seems to be higher that the corresponding novelties/adaption processes can be achieved in time in the next decades until 2050!
- Half or more of the residential and commercial heating needs to be provided by heat pumps already in 2035, unless carbon dioxide removal technologies are available!
- The same is true (half or more) for passenger transport and BEV, but already in 2030!
- Removing the last 1/3 of the emissions from 2030 to 2050 expects increases of CO_2 prices several times and remains at very high levels in 2050!
- ….

openENTRANCE SCENARIO EXPLORER



https://data.ece.iiasa.ac.at/openentrance

Acknowledgements

open ENTRANCE https://openentrance.eu/

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