

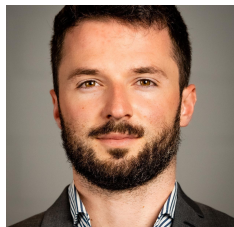


Maximize Impact

**Learn from the Dual Pillars of Open-Source Energy
Planning Tools like PyPSA**

Dr. Maximilian Parzen
Berlin, June 26th 2024

Introduction



Maximilian Parzen

Co-Founder & CEO



**PhD in Energy System Modelling,
MSc in Sustainable Energy Systems**
University of Edinburgh

Our Goal:

Make energy planning more **transparent**, **accessible**, and **collaborative** & make **open-source** tools **adoptable** for companies to **accelerate the energy transition**.

Our Approach:

- Perform **reproducible** energy planning **studies**
- Advance **open-source software** and **open data** for energy planning
- Provide reliable industry **support** and **training**

Our Customers:

- Transmission System Operators (e.g. TransnetBW)
- Non Governmental Organizations (e.g. Agora Energiewende, EDF)
- Universities (e.g. Stanford University)
- Industries (e.g. Storage Manufacturers)
- Philanthropies (e.g. Breakthrough Energy, European Climate Foundation)

GOAL:

1. Learn about **Open Modelling**
2. Learn about **Dual Pillars of OS**
3. Learn about **GAMS OVER**

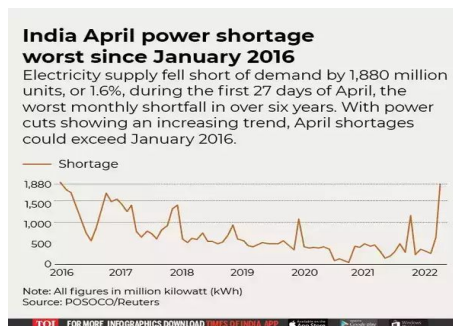
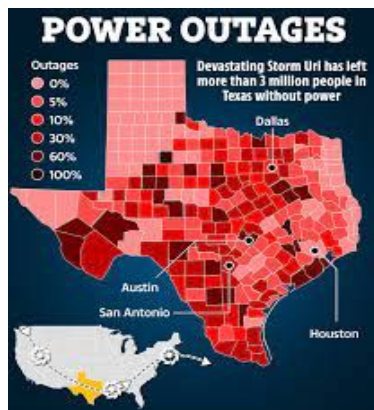
Complex energy system models inform:

- **Policymakers** for policy regulation and net-zero emission strategies
- **Investors** for multi-billion investment decisions
- **System operators** for stable, secure and cost efficient operation
- **NGOs** for monitoring the energy transition

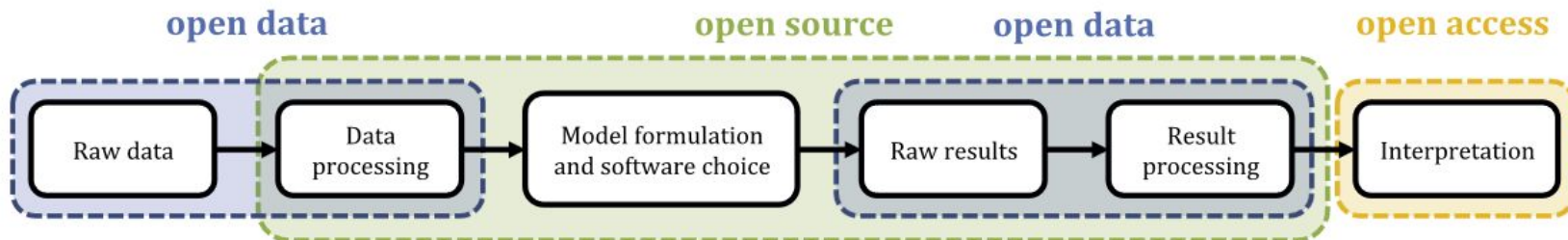
The Challenge

“Black-Box” models are the standard, meaning:

- Results can never be fully **reproducible**
- Results are **difficult** to discuss
- Results can be created with a **secret bias**
- Planning is **slow, expensive** and **restricted** to existing tool features



The Solution -> Open Modelling



open data & free and open-source software → transparency & reproducibility

Benefits:

- + No need to reinvent the wheel (models and data workflow already exists)
- + Accelerated research studies (researchers can use validated models for their studies)
- + Faster methodological innovation (new methods can be directly implemented & tested)

= Faster and better energy transition planning

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Which open model is right for you?

Hourly
resolution
for 8760

More than
100 nodes

- One that does your **job**

Co-optimization of
investment+operation

Good grid physics
(LOPF instead of
NTC)

...





Pick any well financed tool

“Well-financed open-source tools within the same category tend to converge on similar technical features due to high tech diffusion.” - Matthias Frippe + Jesse Jenkins

Which open model is right for you?



https://unsplash.com/@two_tees

- One that does your **job**
- One that is **trusted**
- One that has a large **user + dev community**
- One that has a good **support network**

Which open model is right for me?




https://unsplash.com/@two_tees

TECHNICAL FEATURES

- One that does your **job**
- One that is **trusted**
- One that has a large **user + dev community**
- One that has a good **support network**

NON-TECHNICAL FEATURES

The Dual Pillars of Open Energy Planning



“For practical adoption, not only technical features are important but also non-technical features like the size of the commercial support network and the trend of total number of users.” - Max Parzen



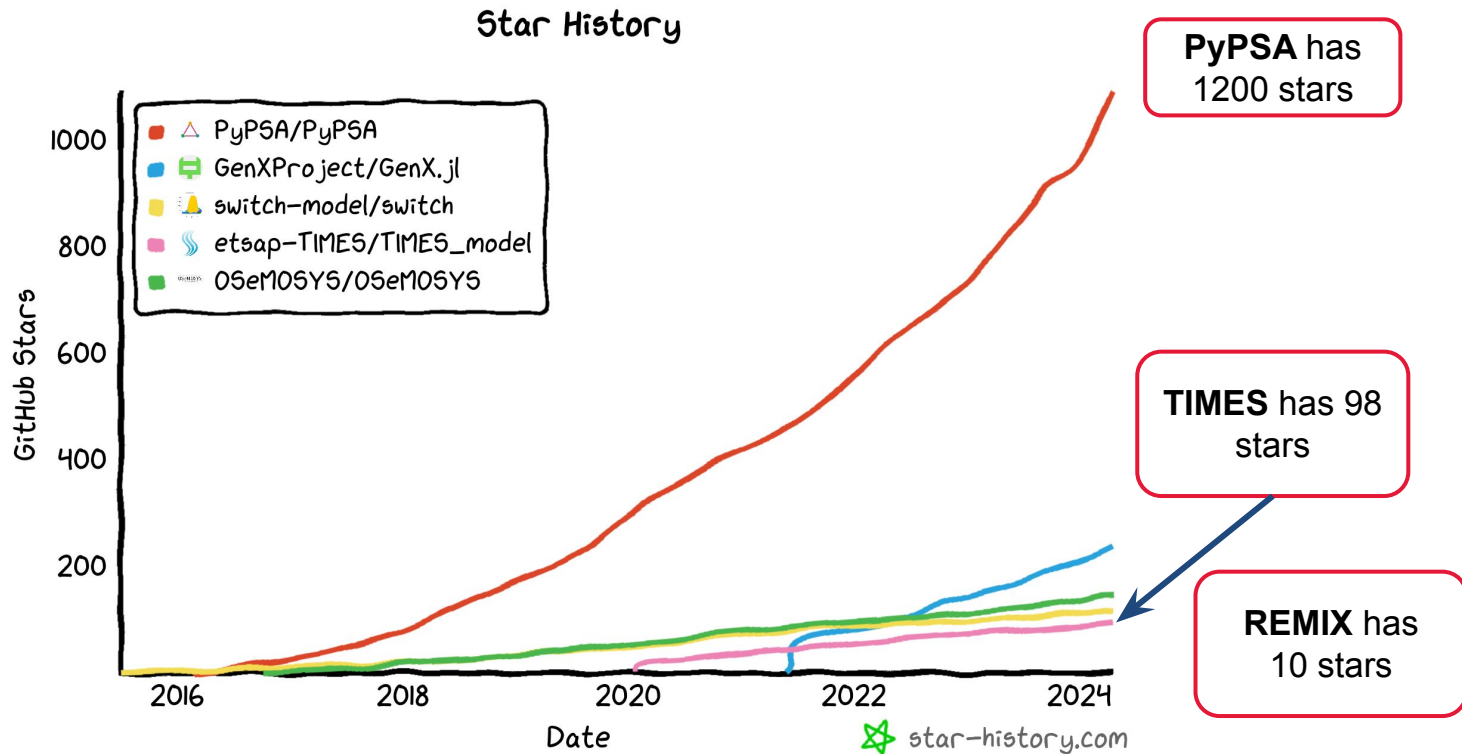
Pick any well financed tool + with a great “ecosystem”



PyPSA

**An open source toolbox for simulating and optimising
modern power and energy systems**

PyPSA - Tool Adoption Indicators



PyPSA - Tool Adoption Indicators

downloads 292k

downloads/month 7k

Forks (Code Copies): 429

Issues (Ideas/Bugs):

- 83 Open
- 233 Closed

Pull Requests (Code changes):

- 22 Open
- 514 Closed

Discord members: ~1000

Google Groups members: 749

Questions per month: 70

Total questions answered: ~1500

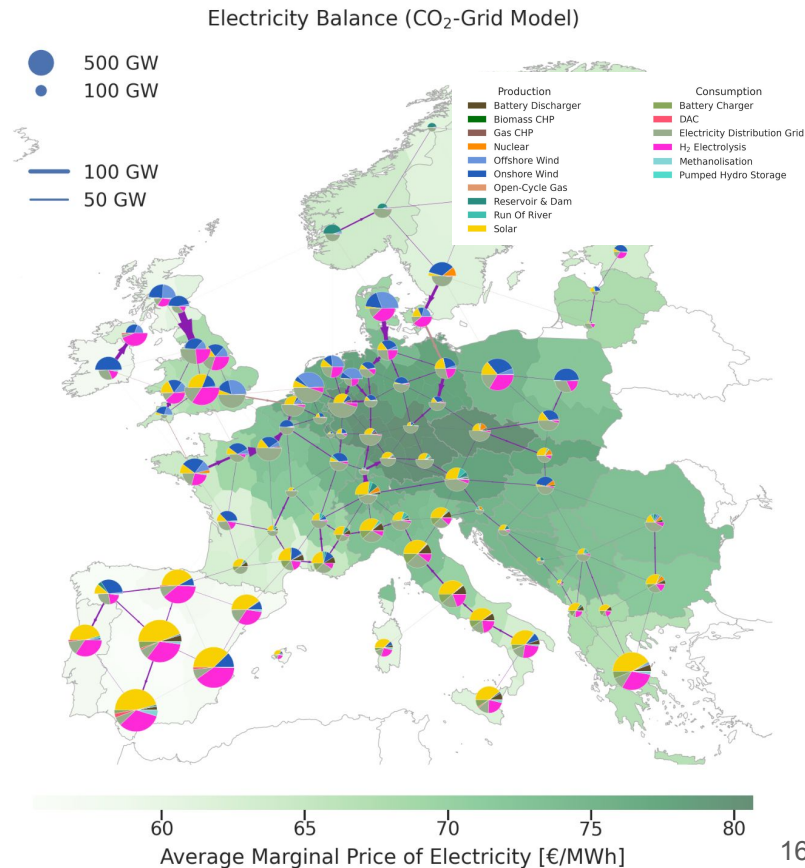
Info:

TIMES has **2 closed PRs**
REMIX has **0 closed PRs**

More than **2000 closed Pull Request** in the models
PyPSA-Earth, PyPSA-USA,
PyPSA-Eur

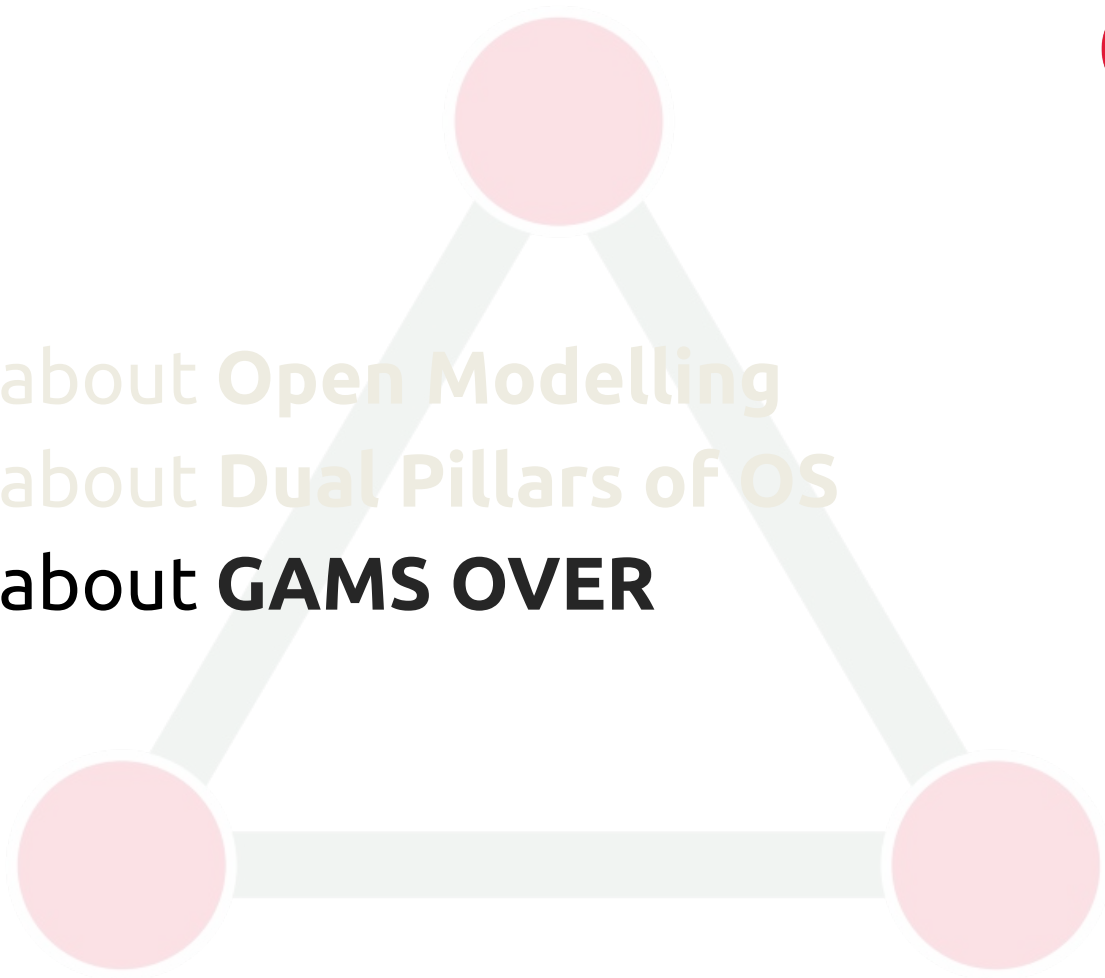
Performance example

	Power Only	Sector Coupled
Type	Single year	Single year
Spatial Resolution	110 nodes	110 nodes
Temporal Resolution	3h	3h
# Constraints	11.4M	46M
# Variables	5.4M	21M
# Non-Zeros	23.3M	112M
Memory Peak	11 GB	80 GB
Solving time	0.5h	29h

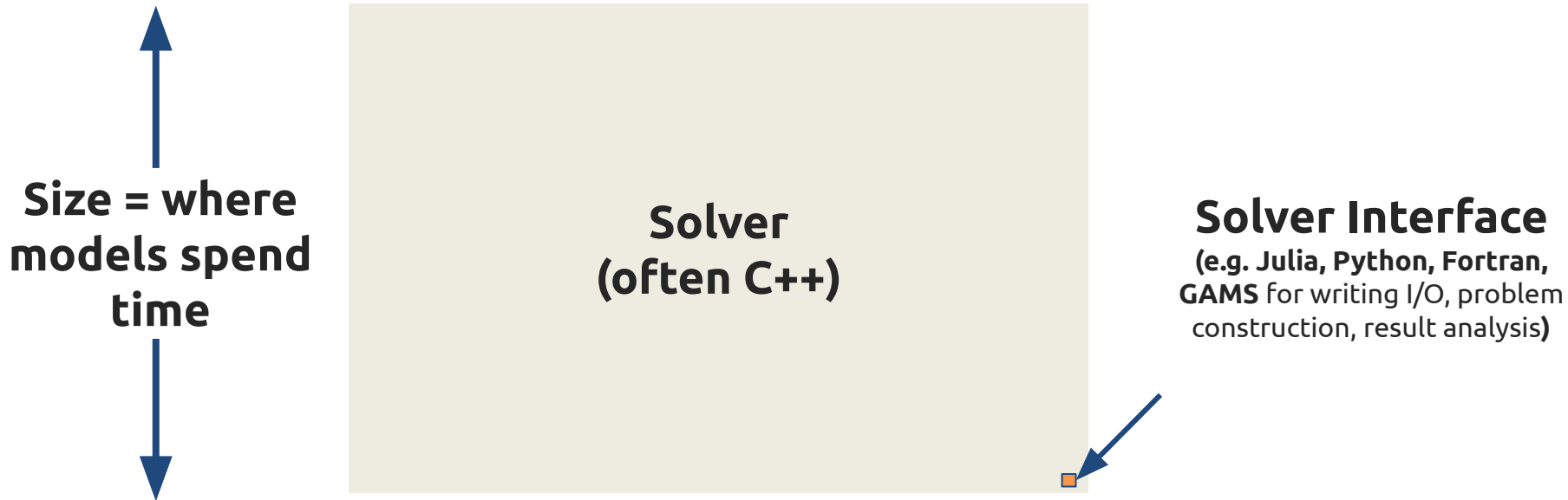


GOAL:

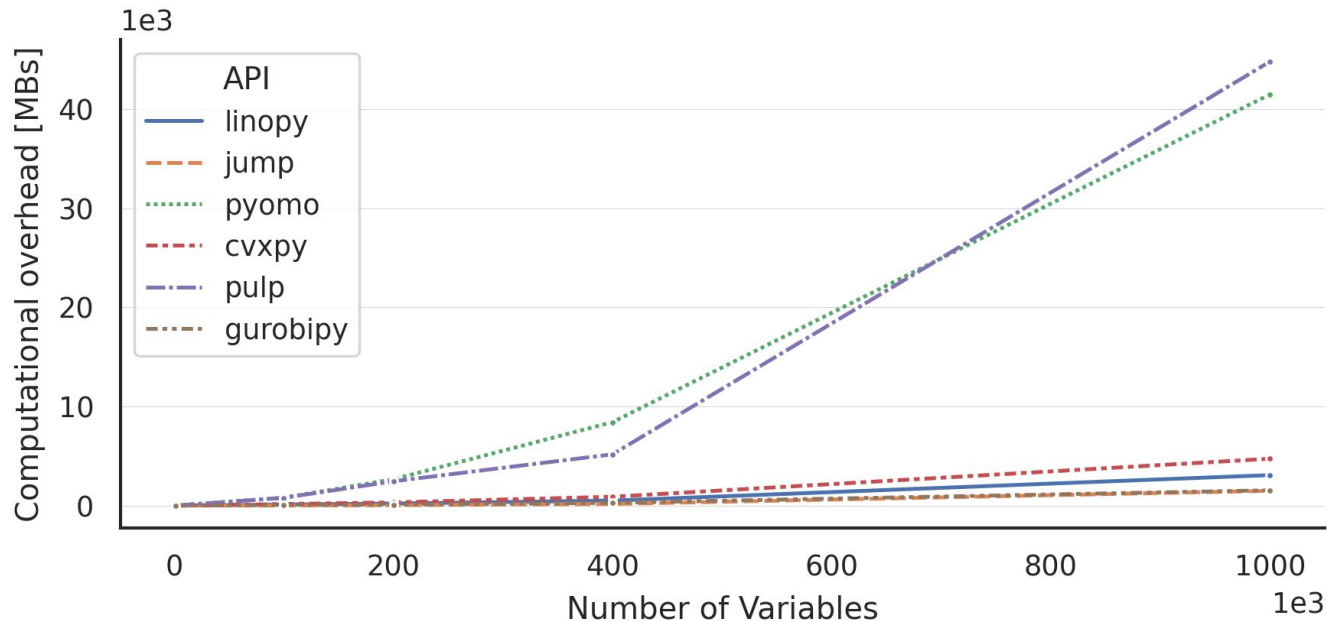
1. Learn about **Open Modelling**
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The **programming language** is not the **speed bottleneck** for capacity expansion and market modelling



Speed and memory matters



pyomo/ pulp

jump/ linopy/
cvxpy/ gurobipy

NEWS - “Python solver interfaces can be faster than other speedy options”

Solver interface benchmark

Time (second) to generate model and pass it to Gurobi optimizer.

Model	Variables	C++	PyOptInterface	JuMP	gurobipy	Pyomo
fac-25	67651	0.2	0.2	0.2	1.2	4.1
fac-50	520301	0.8	1.2	1.8	9.7	32.7
fac-75	1732951	2.7	4.1	6.6	32.5	119.3
fac-100	4080601	6.3	10.0	17.8	79.1	286.3
lqcp-500	251501	0.9	1.5	1.3	6.3	23.8
lqcp-1000	1003001	3.7	6.0	6.1	26.7	106.6
lqcp-1500	2254501	8.3	14.0	17.7	61.8	234.0
lqcp-2000	4006001	14.5	24.9	38.3	106.9	444.1

Python Julia

https://www.linkedin.com/posts/maximilian-parzen-b047a1126_python-pyoptinterface-optimization-activity-7185910141442043905-3Mqv

No need to use GAMS = GAMS OVER

*“To use TIMES (OS) you
must use GAMS (Non-OS)”*

+ Risk of being considered as
fake open-source project

It definitely does not qualify
under FOSS definition but
might pass the OSI
definition. (Legal advice
needed)



Takeaways:

1. Open modelling **is great!**
2. PyPSA is **very popular** and **powerful**
3. No need for **GAMS (free yourself)**



Appendix

#NO #PYPSA #FANATICS

We have multiple open source core maintainers in the team:

- **PyPSA** (Max, Martha, Fabian, Katia, Davide, Hazem)
- **TIMES** (Sid)
- **Energy-Rt** (Oleg)
- **Temoa** (Daniel)

... our goal is to **help people** to adopt good OS solutions!

IMPACT THESIS

“Open energy modelling accelerates the transition
towards 100% sustainable energy”

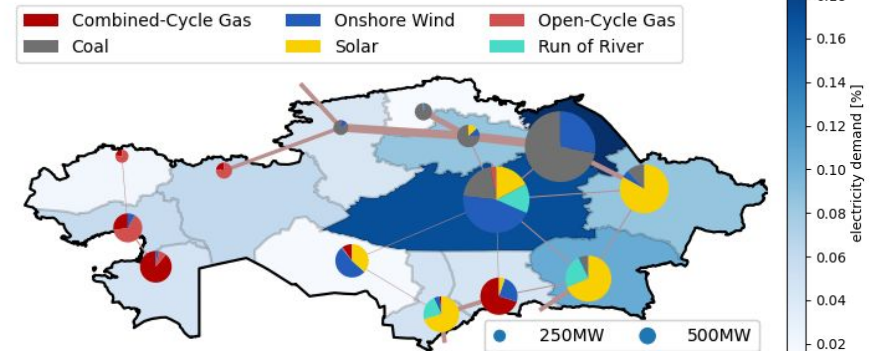
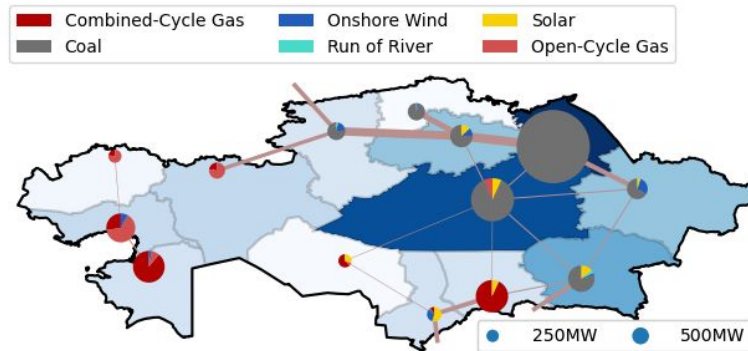
WHAT WE DO

1. Perform **reproducible** best-practise **studies**
2. Support global **adoption** (training, support, tech, ...)
3. Advance **open-source software** and **open data**

Example - Supporting NGO/ Think Tanks

OET worked with non-profit **Agora Energiewende** to create a policy study advocating for more ambitious RES goals in Kazakhstan. Why? Their modelling resources were limited and we provided affordable, high-quality and easy to reproduce study results.

	PyPSA [TWh]	national report [TWh]	error [TWh]	PyPSA [%]	national report [%]	error [%]		installed capacity [GW]	capacity projection (2030) [GW]
carrier							carrier		
gas	20.358883	21.73	1.371117	18.753352	20.103617	1.350265	Combined-Cycle Gas	3.48000	3.480000
coal	74.573022	74.47	0.103022	68.692087	68.896290	0.204203	Open-Cycle Gas	1.62540	1.625400
onwind	1.718037	1.08	0.638037	1.582550	0.999167	0.583383	Coal	12.96700	12.967000
hydro	10.862888	9.51	1.352888	10.006225	8.798224	1.208001	Onshore Wind	0.64870	8.239741
solar	1.048470	1.30	0.251530	0.965786	1.202701	0.236915	Run of River	0.06278	2.132999
							Solar	0.82182	4.568450



Example - Supporting Transmission System Operators

OET works with **German TSO, TransnetBW**, to improve their open energy system modelling setup. **Why?** Our work lead to quicker updates, better software quality, easier OS contributions and costs savings.



Example - Supporting Openmod and Training People

OET was invited for a training at **Stanford University**. Why? We have more than a handful “world-class” **open-source maintainers and creators**. We took the opportunity to also revive openmod in US.

Stanford
Doerr
School of
Sustainability

Stanford | ENERGY
Bits & Watts Initiative

OET Open
Energy
Transition
from the creators of PyPSA meets Earth



openmod open energy
modelling initiative





Join us
and support the global
adoption of open energy
planning



Dr. Maximilian Parzen

CEO, Co-founder



Dr. Martha Maria Fryszta

Head of Energy and Power System
Modeling, Co-founder



Victor Martinez MSc MBA

Head of Operations and Strategy



Dr. Ekaterina Fedotova

Head of Energy and Climate System
Modeling



Dr. Fabian Hofmann

Senior Optimization and Energy System
Modeling Expert



Dr. Oleg Lugovoy

Senior Energy System Modeler



Asst. Prof. Dr. Davide Fioriti

Expert in Global Energy System
Modeling, Co-founder



Dr. Siddharth Krishna

Computer Scientist & Software Engineer



Dr. Fabrizio Finozzi

Big Data Software Developer



Dr. Mario Dzamarjia

Energy Systems Modeler



Lukas Franken

Senior Energy System Modeler



Yerbol Akhmetov

Energy System Modeling Expert



Akshat Mittal

Full-Stack Developer



Hazem Abdel-Khalek

Expert in Sector-Coupled Energy System
Modeling, Co-founder



Emmanuel Bolarinwa

AI Engineer



Bryan Ramirez

GIS Engineer, WebGIS Research

