The Energy Transition Model (ETM)

to model multi-sectoral energy transitions across energy supply chains in PICTs

Edoardo Santagata
PhD Candidate, *The University of New South Wales | Collaboration on Energy and Environmental Markets*

ENERGY MODELLING PRINCIPLES

Energy Supply Chain **RESOURCES** → **CONVERSION** → **DELIVERY** → **CONSUMPTION**

MODELLING: simplified & organised model structures to represent every step of the supply chain

Accurately represent future scenarios

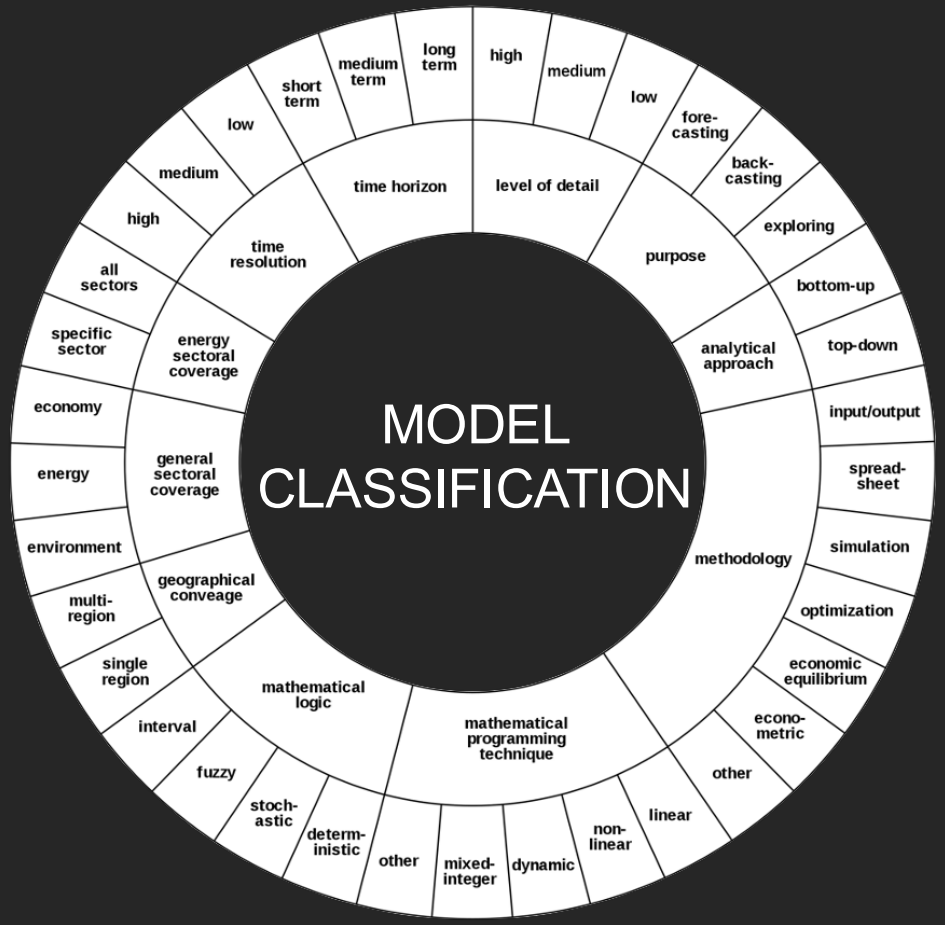
Provide flexible options to forecast demand and the uptake of specific technologies

Assist with energy planning & policy making

Assess the outcomes of specific technologies and trends to make better decisions regarding capacity and policy mechanisms

Track progress against strategic targets

Determine how likely an energy system is to meet current targets relating to specific technologies and emissions



REVIEW

of available modelling tools to investigate energy transitions

Challenges encountered

- Lack of energy data for the Pacific
- Modelling options do not reflect Pacific energy challenges
- Complex user input requirements
- Limited case study applications to test practicality for planning
- Restricted system compatibility
- Barriers to accessibility
- Developed without stakeholder consultation
- Lack of adaptable dashboards
- Requirement of extensive specialised training
- Selective outputs

Some examples…

IRENA FlexTool

openCEM

WASP
Wien Automatic System Planning Package

HOMER Energy by UL

OSeMOSYS
Open Source Energy Modelling System

ENERGY TRANSITION MODEL
Independent, Comprehensive and Fact-based

Global Energy and Climate Model

PLEXOS BY ENERGY EXEMPLAR

LEAP

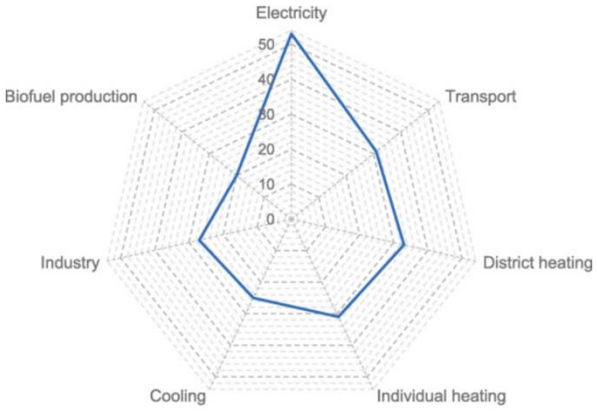
PRIMES Energy System Model

ENPEP

Energy PLAN

MESSAGE

PyPSA



Model family	Examples	Primary focus
Energy system optimization models	MARKAL, TIMES, MESSAGE, OSeMOSYS	Normative scenarios
Energy system simulation models	LEAP, NEMS, PRIMES	Forecasts, predictions
Power systems and electricity market models	WASP, PLEXOS, ELMOD, EMCAS	Operational decisions, business planning
Qualitative and mixed-methods scenarios	DECC 2050 pathways, Stabilization wedges	Narrative scenarios

From 'Energy systems modelling for twenty-first century energy challenges' (Pfenninger et al., 2014)

MODEL SCORING

Vanuatu Case Study
multi-sectoral tools

TOOL	Key Model Factors						SCORE
	Intuitive Interface	Integrated Database	In-built Training	Simulation-based	Pragmatic Outputs	Open-source	
OSeMOSYS	X	~	X	✓	✓	✓	3.5
TIMES	X	X	X	✓	✓	✓	3
Energy Transition Model (ETM)	✓	✓	✓	✓	✓	✓	**6**
Global Energy and Climate Model (GEC)	N/A	X	X	✓	✓	X	2
LEAP	X	X	~	✓	✓	~	3
PLEXOS	X	✓	X	✓	✓	X	3
MESSAGE	X	X	X	✓	✓	~	2.5
PRIMES	N/A	X	X	X	✓	X	1
EnergyPLAN	X	X	X	✓	✓	✓	3
ENPEP-BALANCE	X	X	~	~	~	✓	2.5

Energy Transition Model (ETM)

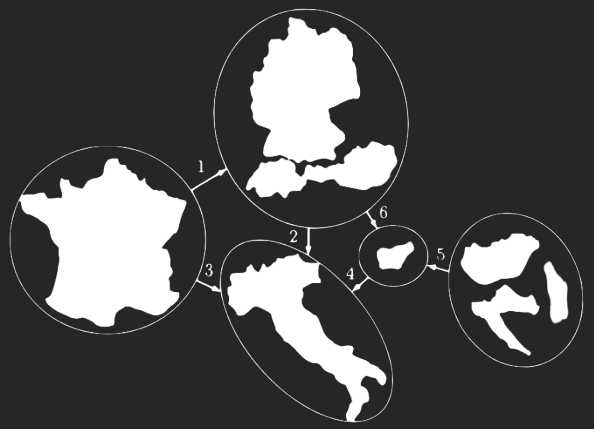
ENERGY TRANSITION MODEL
Independent, Comprehensive and Fact-based

Quintel

Open-source multi-sectoral simulation model with interactive dashboard to produce future energy scenarios and transition plans

https://energytransitionmodel.com/

Available for 28 countries (EU + Singapore)

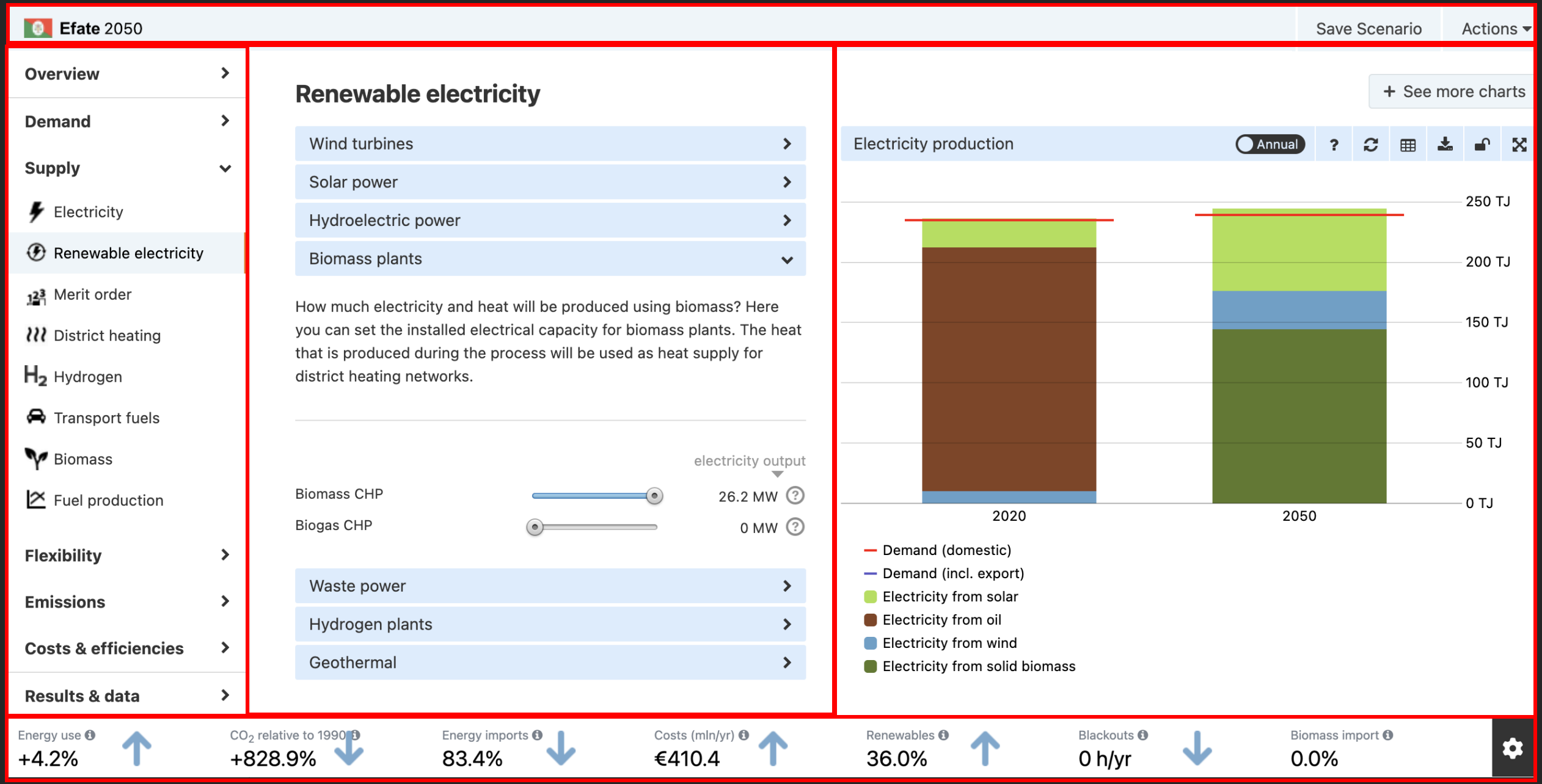


- Adaptable for Pacific
- Extensively tested
- Interactive interface
- Minimal training required
- Multiple output formats (reports, data, infographics)

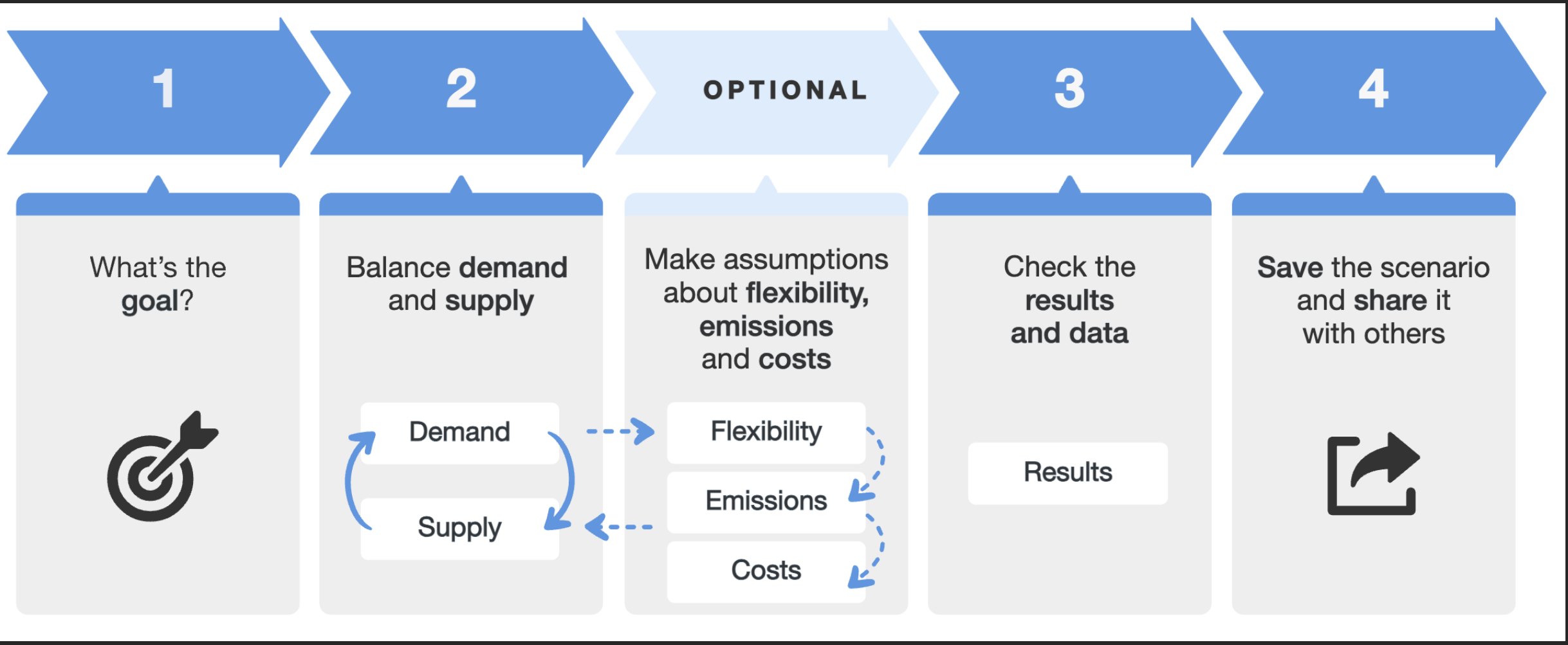
Key characteristics

- Copper-plate model (the “island assumption”)
- Includes an open-source dataset manager to blend tools with databases
- Considers aspects of the energy supply chain that are crucial to the Pacific (e.g. imports, security of supply)
- Auto-adjustment for balance consistency (e.g. industry)
- Extensive documentation available
- Widely used in EU for policy making and strategic plan development with success
- Interactive and adaptable interface
- Minimal training required and highly adept to being used for technical/planning capacity development
- Supports detailed analyses regarding capacity expansion, grid stability, technology deployment, infrastructure requirements, and decarbonisation
- Integration with variety of Python and Excel tools
- Ease of maintenance via data collection framework
- Multiple output formats (charts, reports, raw data, infographics)

A look at the dashboard…



SCENARIO CREATION WORKFLOW



ENERGY TRANSITION MODEL
Independent, Comprehensive and Fact-based

About Features Collaborate English Sign up Log in

Efate 2050 Save Scenario Actions

Overview
Demand
Households 24%
Buildings 2%
Transport 70%
Industry 3%
Agriculture 0%
Other 0%
Supply
Flexibility
Emissions
Costs & efficiencies
Results & data

Welcome!

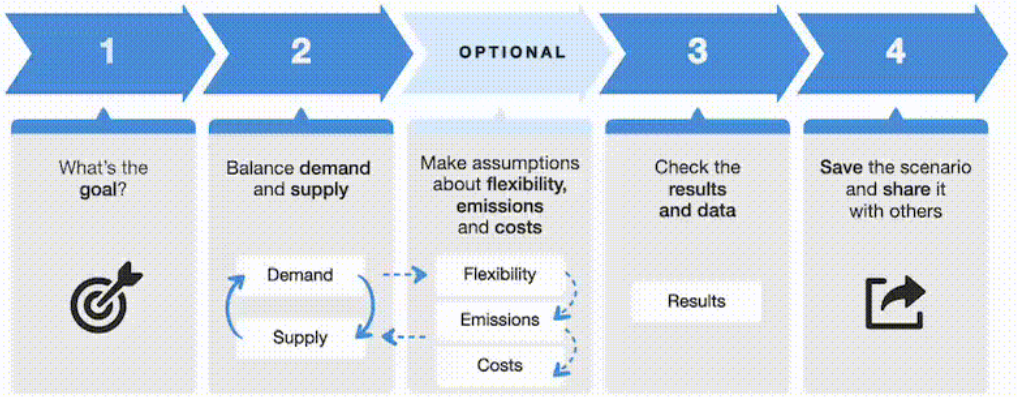
+ See more charts

How does the Energy Transition Model work?

The ETM helps you explore future energy scenarios for a region of your choice. The model is easy to use by following these steps:

1. Before you start, think about the goal of your scenario, then you know what to focus on.
2. The menu on the left displays all sectors that either use (Demand) or produce energy (Supply). For each sector you can use sliders to indicate what you think the future will be like. You can easily undo your changes by resetting your slider, so just play around! For example, you can start with space heating in households or explore transport and mobility.
   Optional: advanced users can use the Flexibility section to match demand and supply on specific timescales, the Emissions section for assumptions on other greenhouse gas emissions or CCUS and the Costs & efficiencies section for cost assumptions or efficiency adjustments.
3. The ETM will immediately show you the result of your actions: at the bottom of your screen, indicators show the impact on the entire system (e.g. CO_2 reduction, energy savings, costs). On the right, charts display specific information for each section of the model. If you lock the chart it will remain visible as you navigate through the model. You can add charts by clicking "see more charts" (top right).
   For a more complete overview of results you can take a look at the scenario report under the header Results & data. You can always return to a certain part of the model to make more changes.
4. You can share your scenario with others by saving your scenario:

Workflow



Energy use	CO_2 relative to 1990	Energy imports	Costs (mln/yr)	Renewables	Blackouts	Biomass import
-0.2%	+874.3%	92.5%	€393	21.4%	n/a	0.0%

https://beta.energytransitionmodel.com/scenario/demand/buildings/insulat...

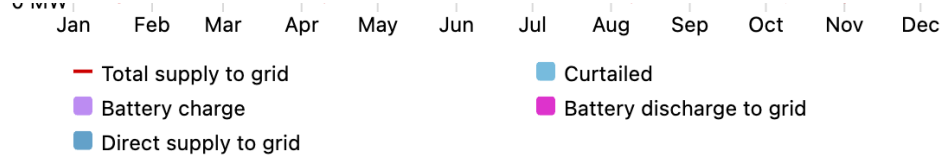
DEMO - EFATE

AVAILABLE OUTPUTS

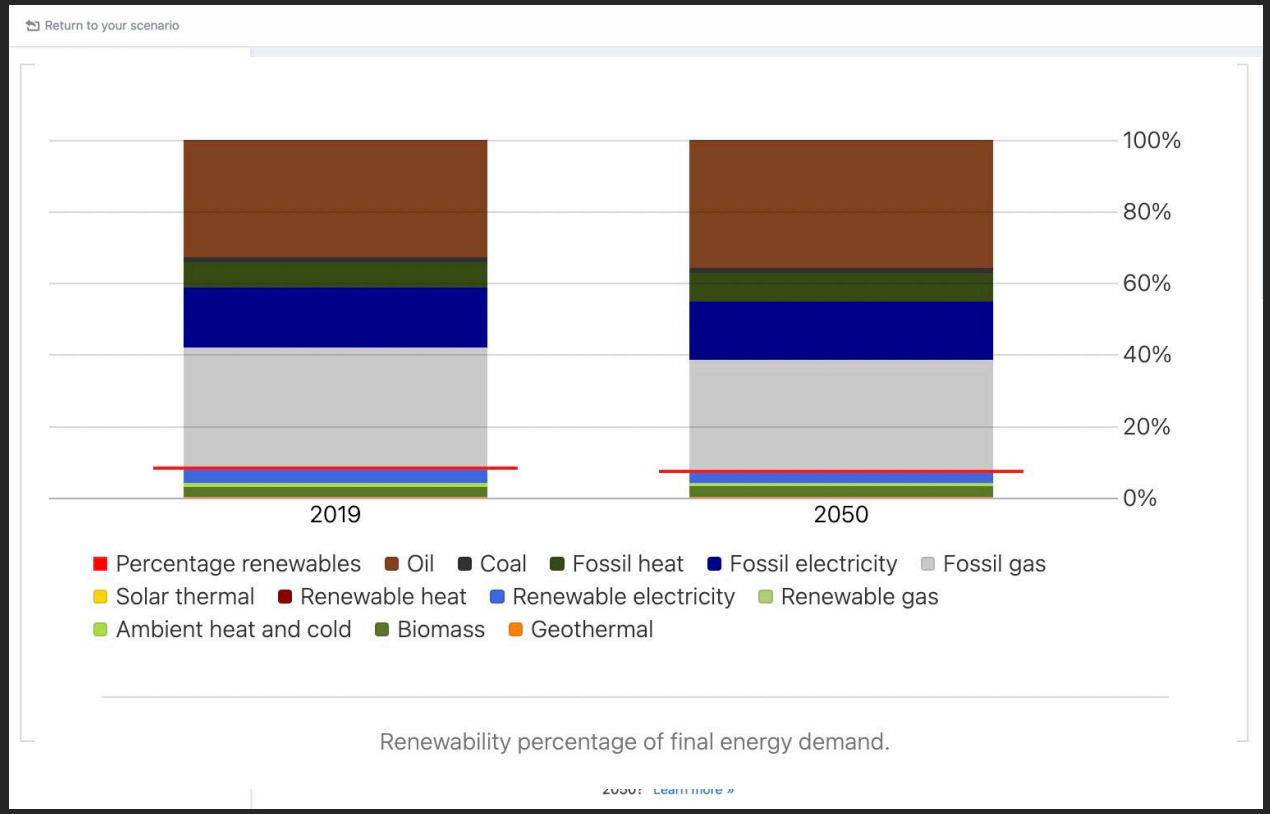
Charts & tables

Electricity network capacity and peaks

	Peak load, present (MW)	Usable capacity, present (MW)	Peak load, future (MW)	Usable capacity, future (MW)	Required additional network (MW)
LV net	7,455.19	9,940.25	8,425.02	9,940.25	0
LV MV transformer	7,455.19	9,940.25	8,425.02	9,940.25	0
MV net	7,902.66	10,536.88	10,350.26	10,536.88	0
MV HV transformer	7,902.66	10,536.88	10,350.26	10,536.88	0
HV net	10,437.07	13,916.09	12,286.85	13,916.09	0
Interconnection net	-	0	0	0	0
Offshore net	-	0	0.85	1	1

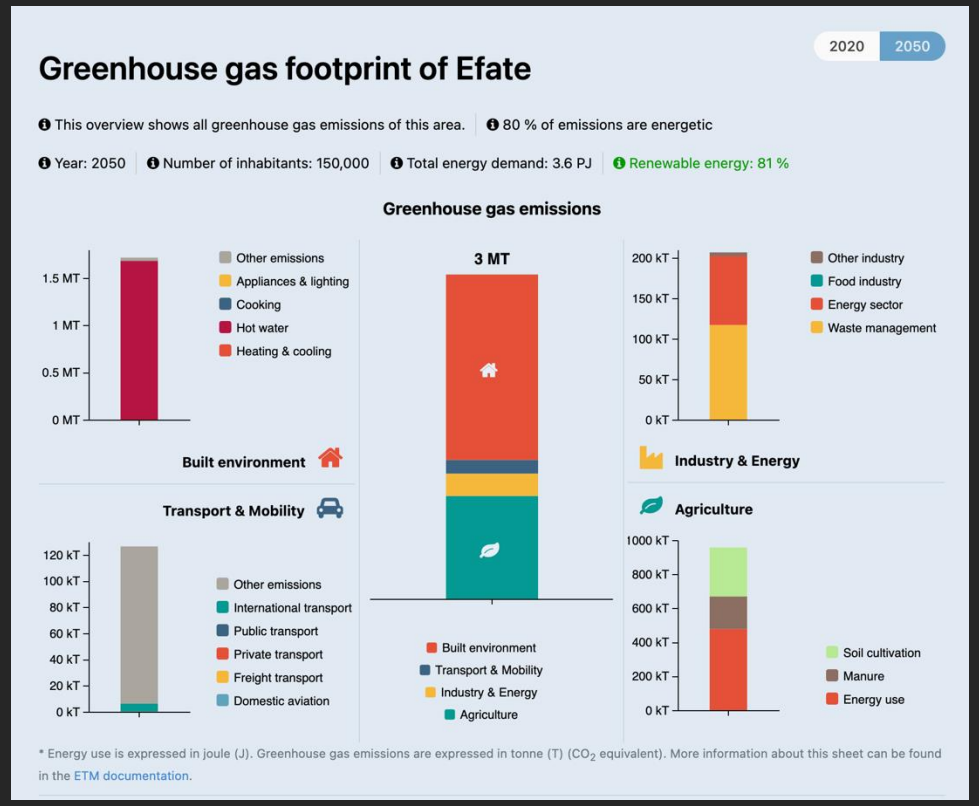


Scenario report

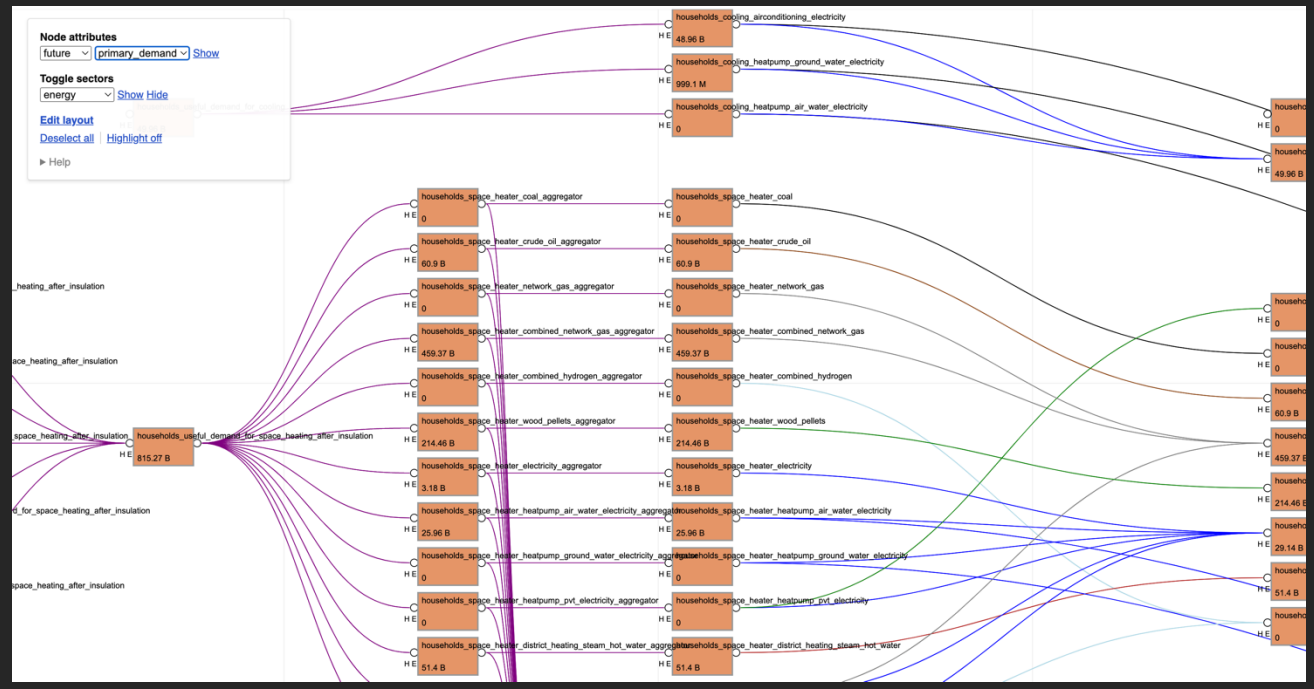


AVAILABLE OUTPUTS

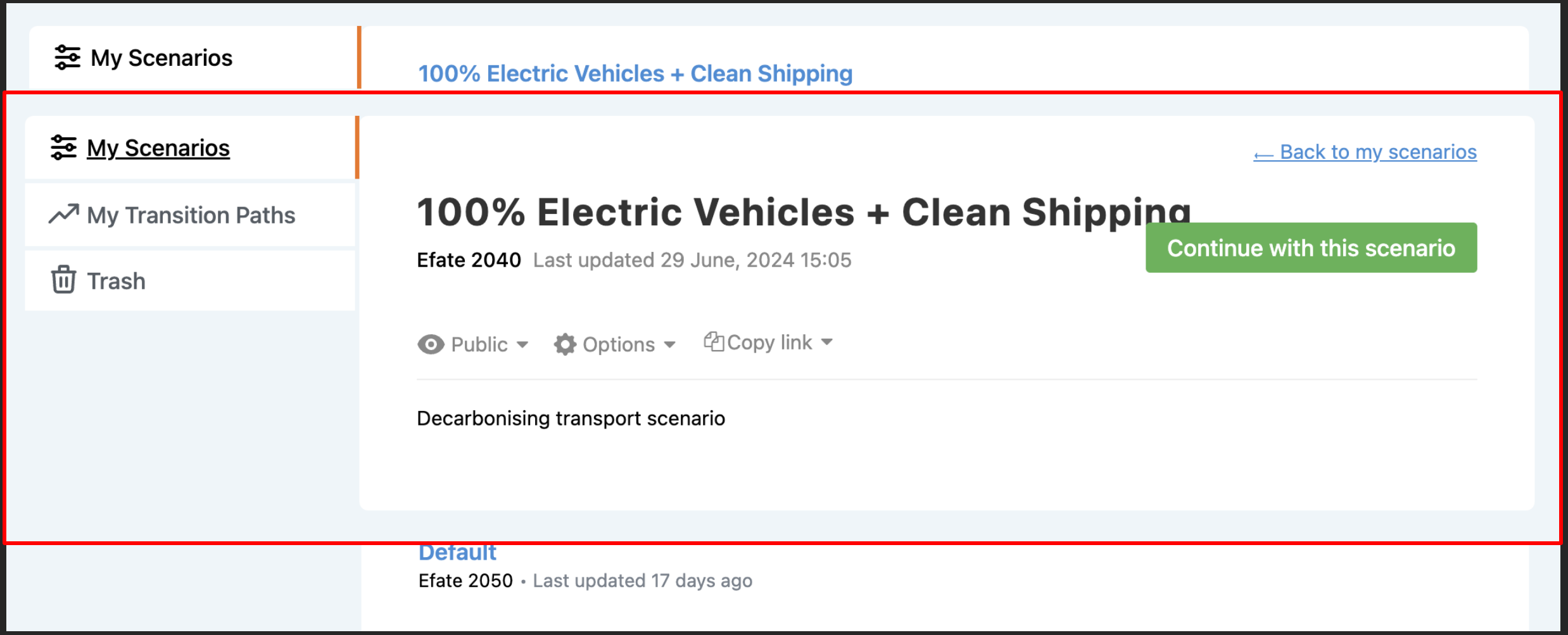
Greenhouse gas footprint infographic



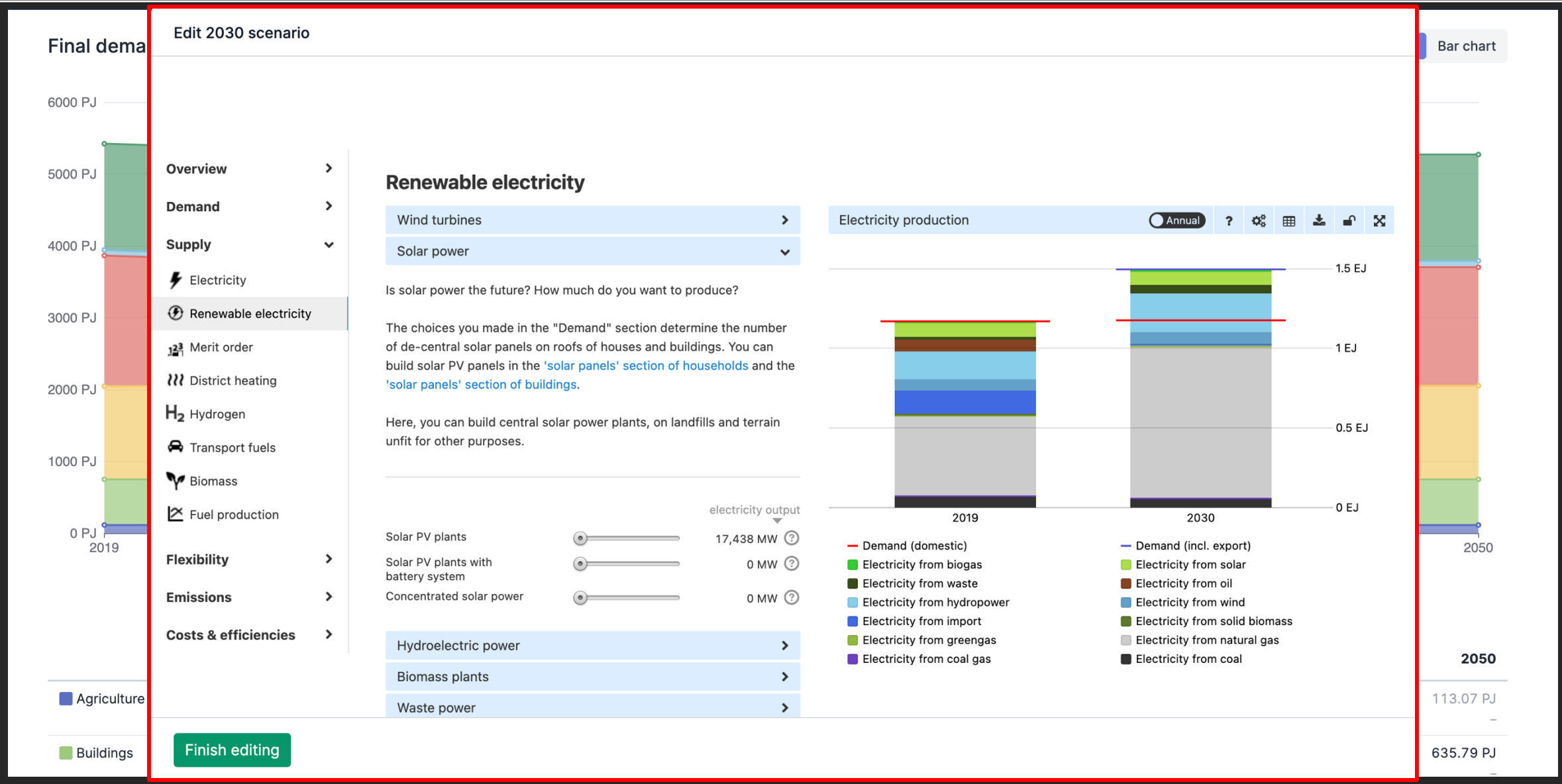
Detailed energy & emissions flows



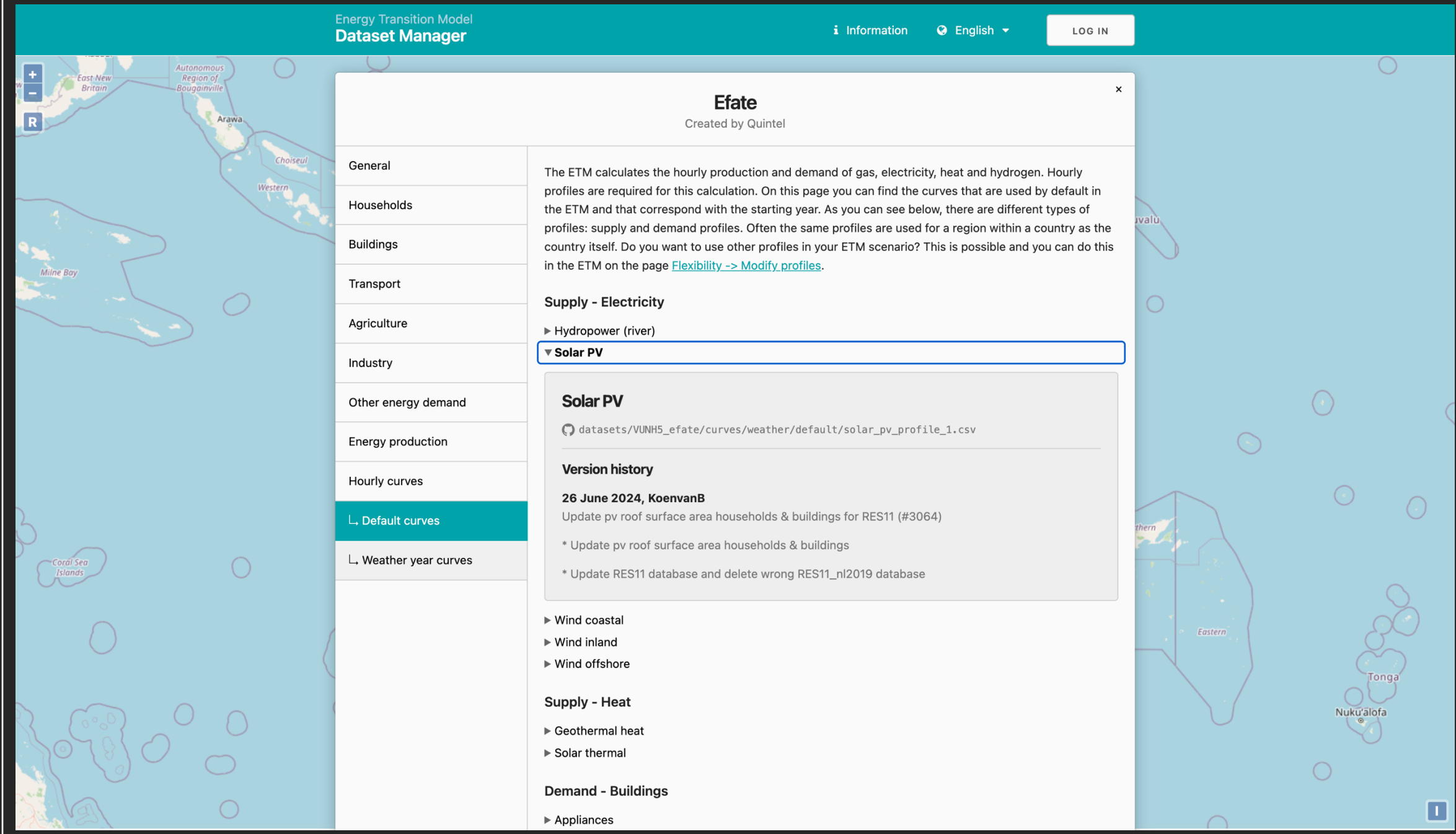
SCENARIO MANAGEMENT



TRANSITION PATHWAYS



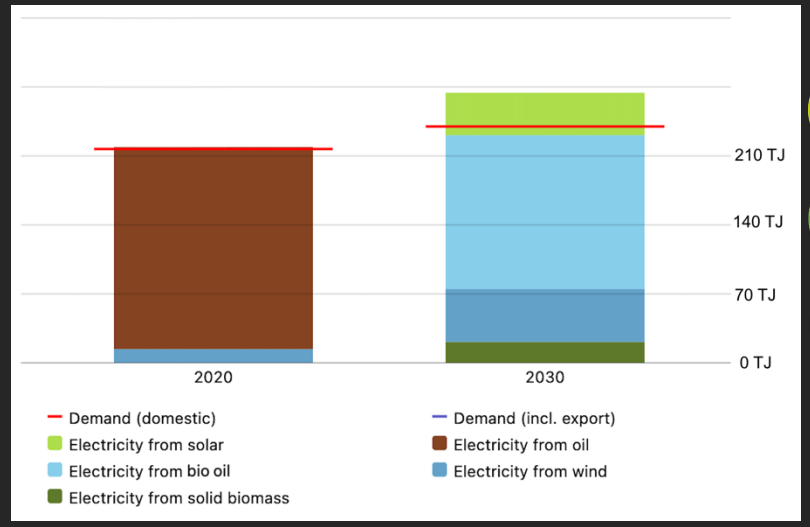
DATASET MANAGER



Scenario Examples

100% Renewable Electricity by 2030 - Efate

Annual Electricity Production



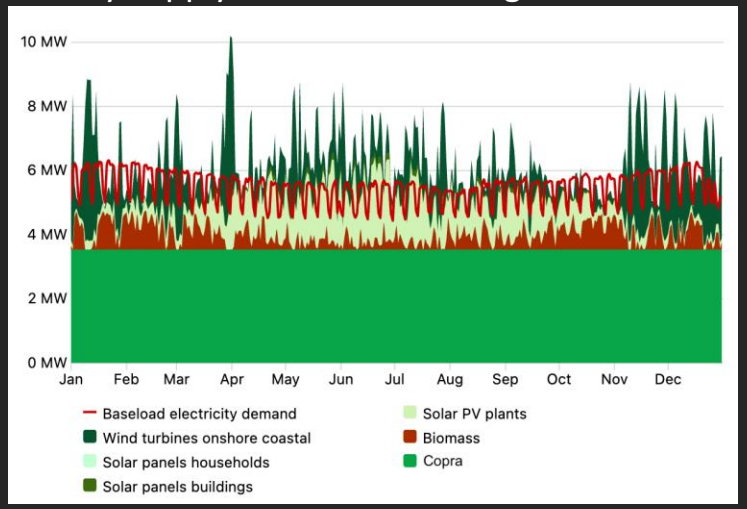
COPRA
6 MW 58%

WIND
12 MW 19%

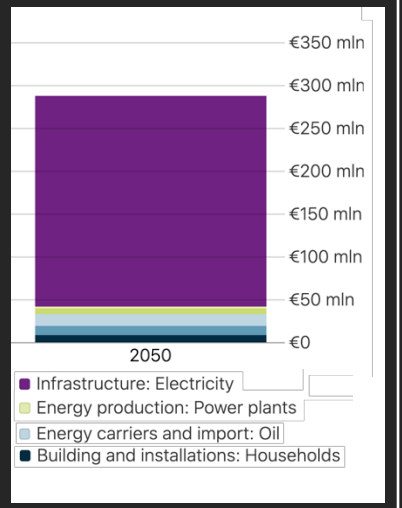
SOLAR
8 MW 16%

BIOMASS
1.5 MW 7%

Hourly Supply-Demand Matching

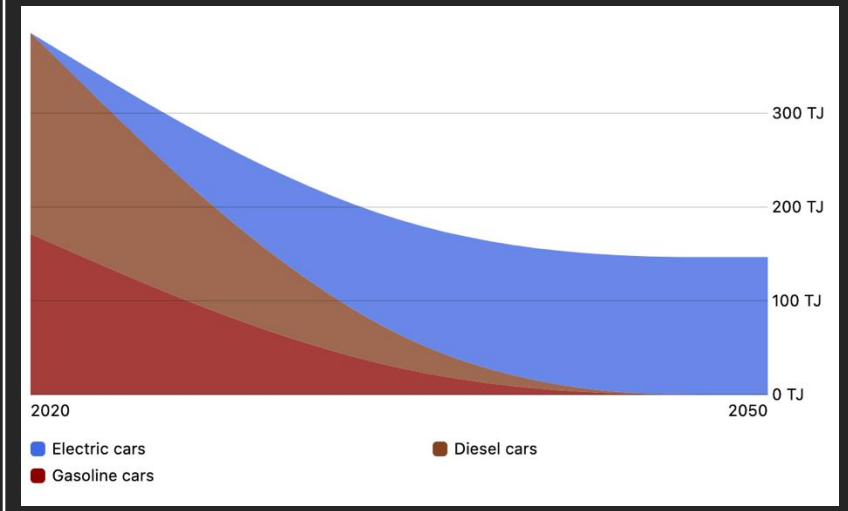


Required Investment

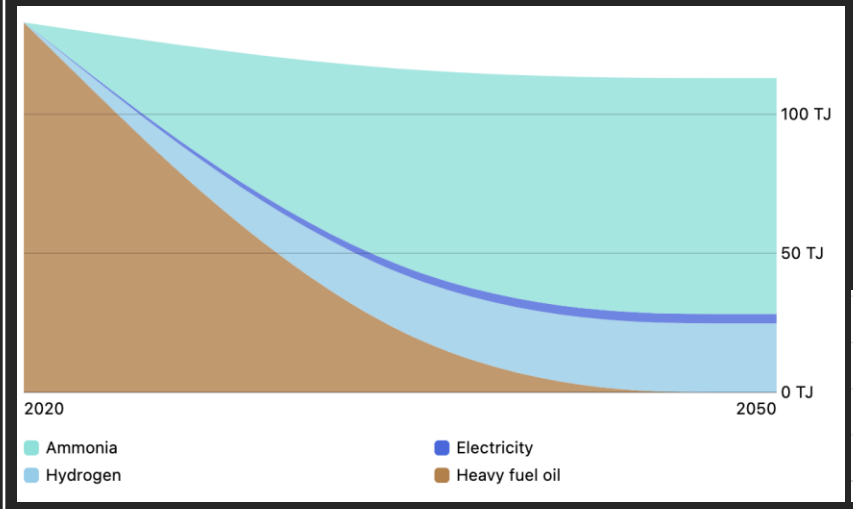


And extending into 2050…

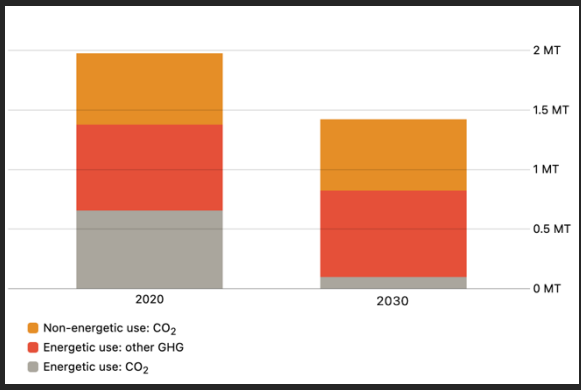
Final demand for cars by technology



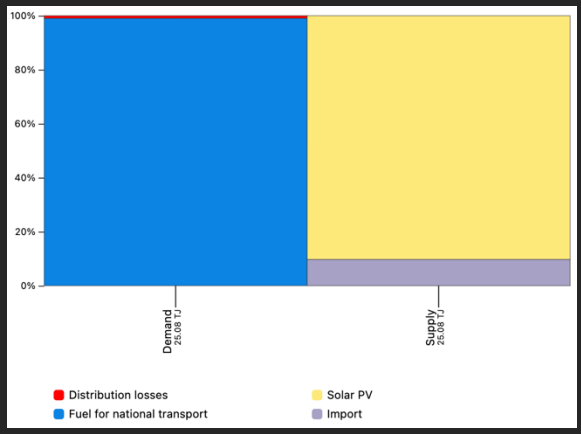
Final demand for domestic navigation by carrier



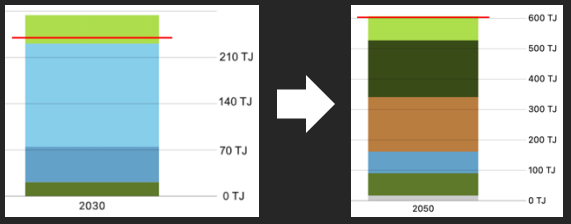
Total emissions



Hydrogen supply & demand



+ 10MW per RE, including geothermal & waste incineration



APPLICATIONS FOR PICTs

Policy Development

Assist in developing effective energy policies and goals to support energy transitions

Geographic Fragmentation

Reflect multi-island context of Vanuatu and develop strategies for independent islands to form a national strategy

Energy Independence

Identify opportunities reduce need for imports and expand local energy resource utilisation + REGIONAL STRATEGY

Resilience & Security

Understand implications and opportunities associated with carrying out key energy transitions and experiencing disastrous weather

Data Centralisation

Opportunity to adopt a proven data collection framework to track national/state energy production, conversion, and consumption

Economic Development

Identify opportunities to expand economy/infrastructure in conjunction with energy sector and create a regional trade network in the Pacific

DATA COLLECTION PROCESS

Vanuatu Case Study

EFAT

EFATEC UNELCO

ESPIRITU SANTO

VANPOWER

MALEKULA

VANPOWER

TANNA

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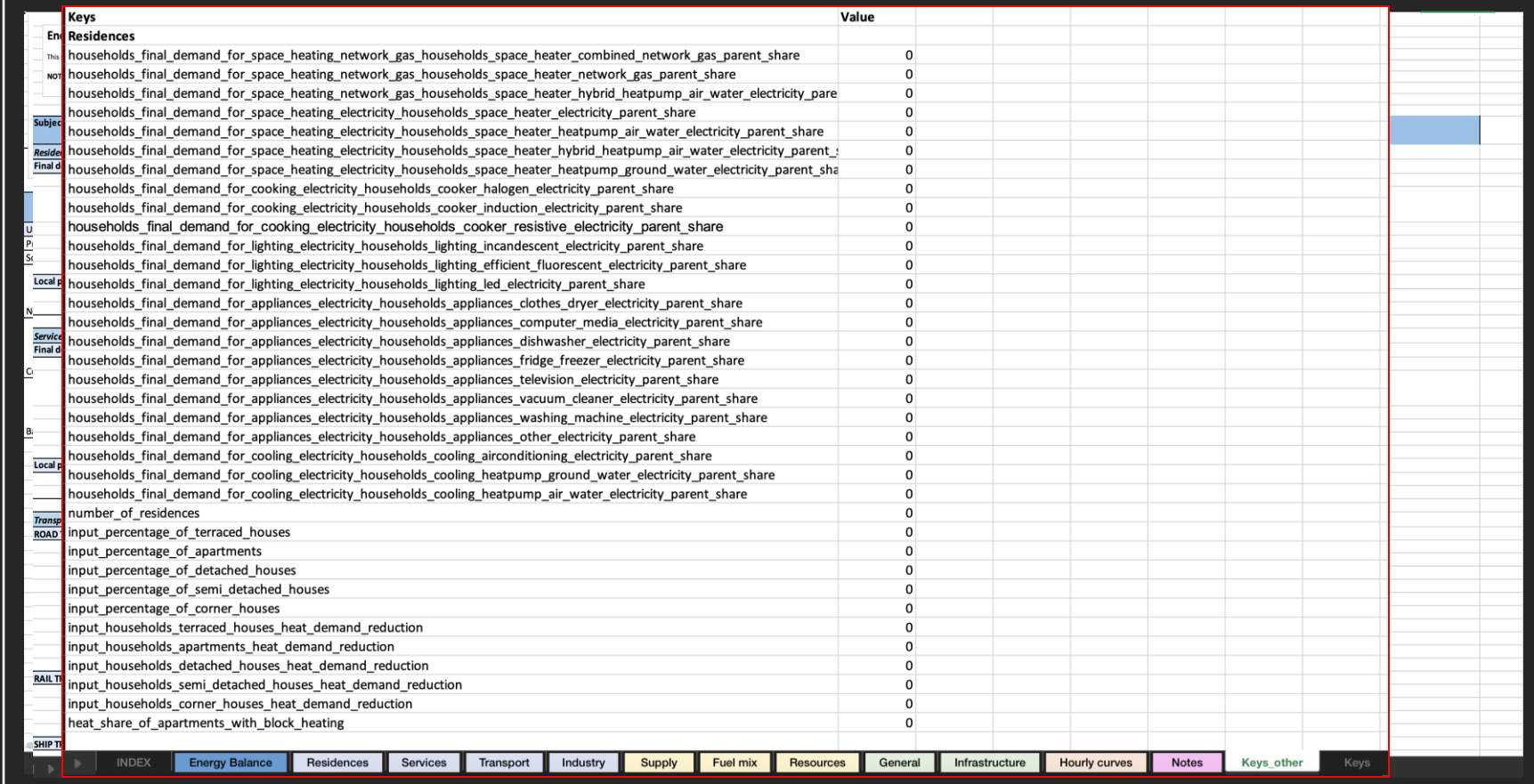

Keys	Value
Residences	
households_final_demand_for_space_heating_network_gas_households_space_heater_combined_network_gas_parent_share	0
households_final_demand_for_space_heating_network_gas_households_space_heater_network_gas_parent_share	0
households_final_demand_for_space_heating_network_gas_households_space_heater_hybrid_heatpump_air_water_electricity_pare	0
households_final_demand_for_space_heating_electricity_households_space_heater_electricity_parent_share	0
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households_final_demand_for_space_heating_electricity_households_space_heater_hybrid_heatpump_air_water_electricity_parent_	0
households_final_demand_for_space_heating_electricity_households_space_heater_heatpump_ground_water_electricity_parent_sha	0
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households_final_demand_for_cooling_electricity_households_cooling_heatpump_ground_water_electricity_parent_share	0
households_final_demand_for_cooling_electricity_households_cooling_heatpump_air_water_electricity_parent_share	0
number_of_residences	0
input_percentage_of_terraced_houses	0
input_percentage_of_apartments	0
input_percentage_of_detached_houses	0
input_percentage_of_semi_detached_houses	0
input_percentage_of_corner_houses	0
input_households_terraced_houses_heat_demand_reduction	0
input_households_apartments_heat_demand_reduction	0
input_households_detached_houses_heat_demand_reduction	0
input_households_semi_detached_houses_heat_demand_reduction	0
input_households_corner_houses_heat_demand_reduction	0
heat_share_of_apartments_with_block_heating	0

INDEX | Energy Balance | Residences | Services | Transport | Industry | Supply | Fuel mix | Resources | General | Infrastructure | Hourly curves | Notes | Keys_other | Keys

Workbook distribution to key stakeholders
(utilities, ministries & departments, authorities)

"keys" = model variables

DATA COLLECTION PROCESS

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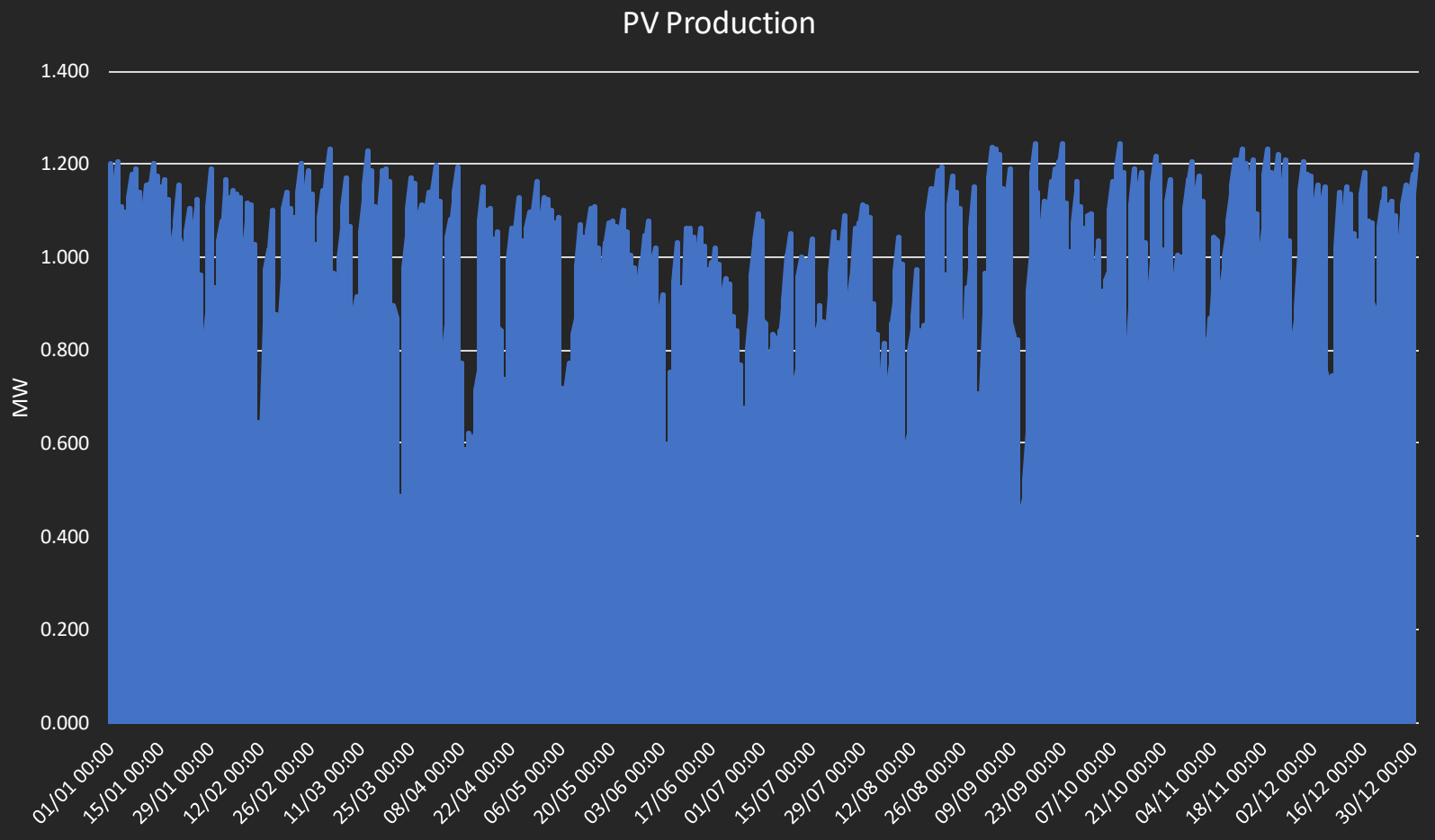

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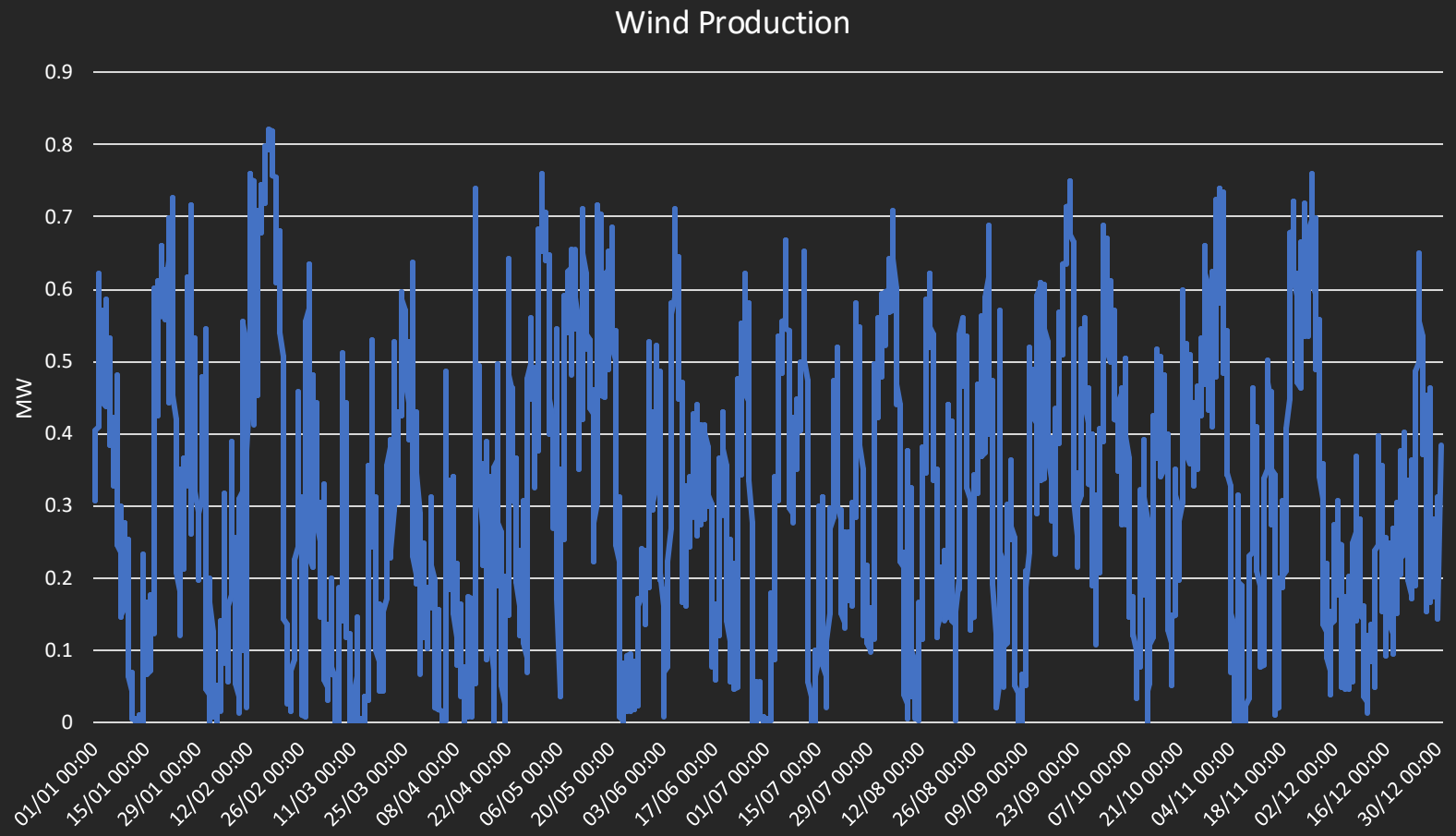

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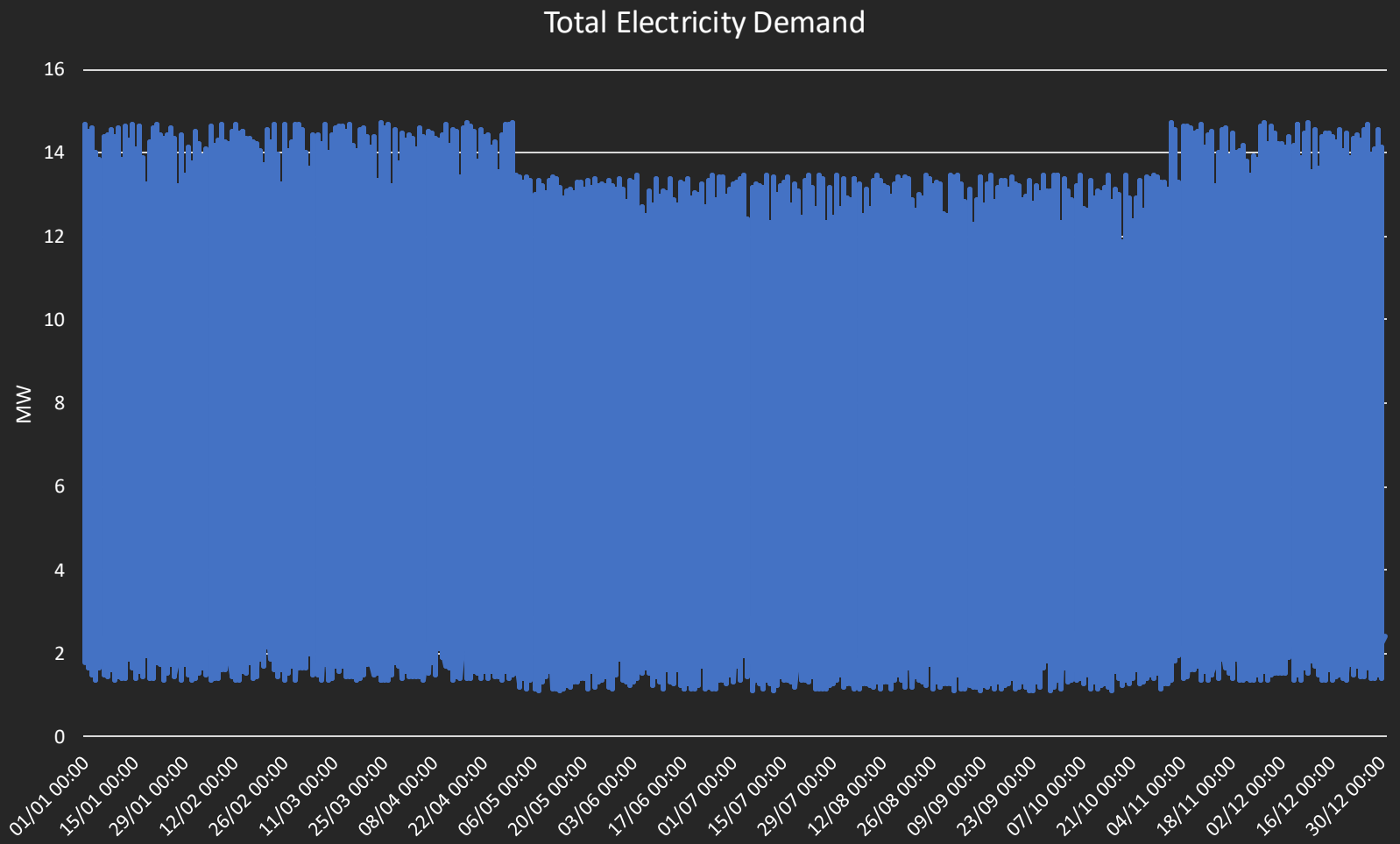

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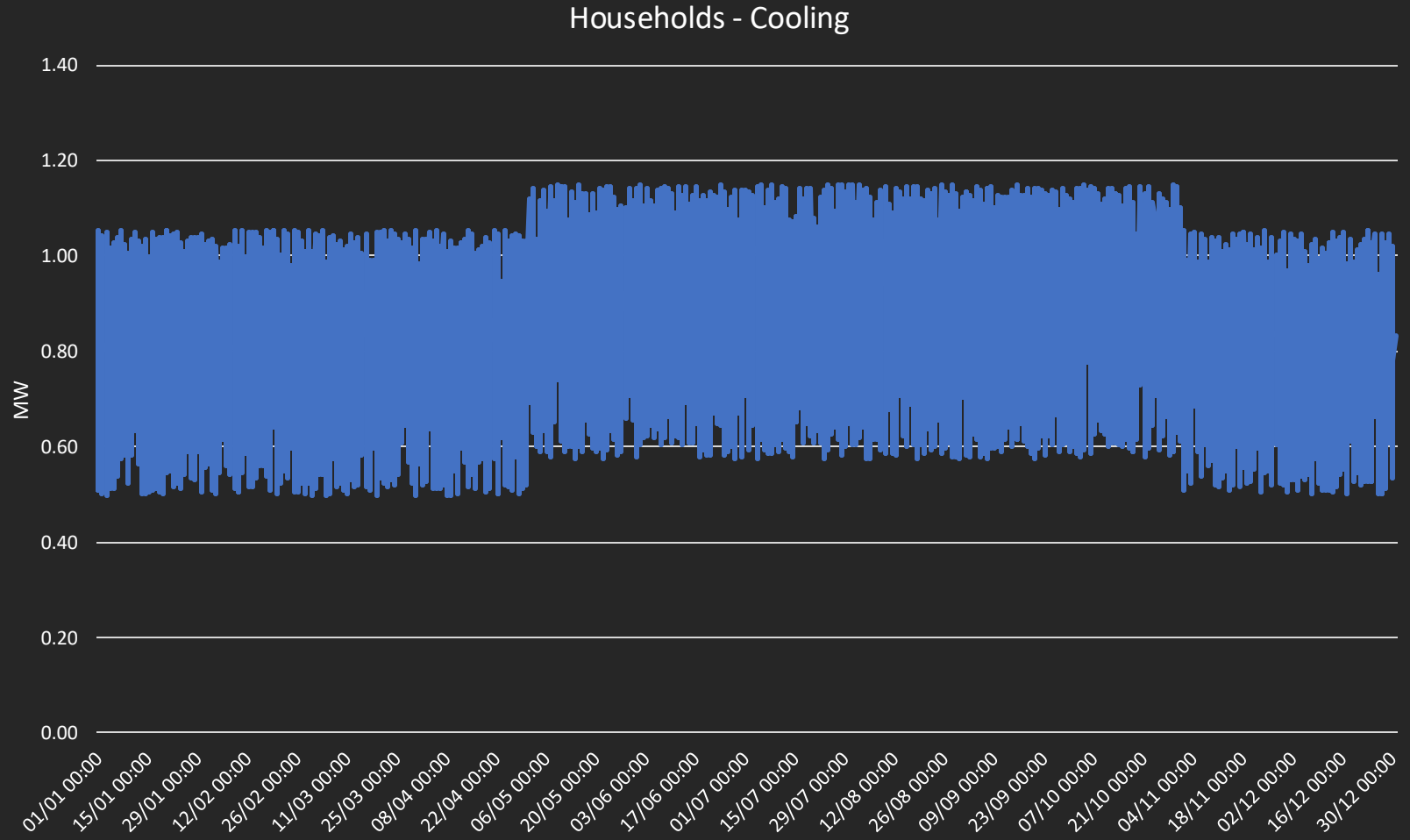

Workbook distribution to key stakeholders
(utilities, ministries & departments, authorities)

"keys" = model variables

DATA COLLECTION STATUS

Assumption-based Model Variables by Data Collection Workbook Category (ideally -> 0%)

Energy Balance	Residences	Services	Transport	Industry	Supply	Fuel mix	Resources	General	Infrastructure	Hourly curves
47%	32%	50%	25%	0%	0%	86%	27%	27%	34%	62%

Weighted Average: 26% (212/806)

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Date	TIME	GEN # 1 P KW	GEN # 2 P KW	GEN # 3 P KW	GEN # 4 P KW	GEN # 5 P KW	T1 P KW	T2 P KW	T3 P KW	Total Kw
1/1/2023	0100H	0	0	0	236	0	300	250	600	1386
1/1/2023	0200H	0	0	0	0	0	0	0	0	0
1/1/2023	0300H	0	533	320	213	208	0	0	0	1274
1/1/2023	0400H	0	0	0	380	0	300	250	550	1480
1/1/2023	0500H	0	0	0	159	0	300	250	550	1259
1/1/2023	0600H	0	0	0	143	0	300	250	500	1193
1/1/2023	0700H	0	0	0	139	0	300	250	500	1189
1/1/2023	0800H	0	0	0	142	0	300	250	500	1192
1/1/2023	0900H	0	0	0	149	0	300	250	500	1199
1/1/2023	1000H	0	0	0	196	0	300	250	500	1246
1/1/2023	1100H	0	0	0	118	0	300	250	400	1068
1/1/2023	1200H	0	0	0	177	0	300	250	400	1127
1/1/2023	1300H	0	0	0	136	0	300	250	400	1086
1/1/2023	1400H	0	0	0	135	0	300	250	400	1085
1/1/2023	1500H	0	0	0	122	0	300	250	400	1072
1/1/2023	1600H	0	0	0	148	0	300	250	400	1098
1/1/2023	1700H	0	0	0	132	0	300	250	400	1082
1/1/2023	1800H	0	0	0	176	0	300	250	400	1126
1/1/2023	1900H	0	0	0	0	322	300	250	500	1372
1/1/2023	2000H	0	0	0	0	326	300	250	500	1376
1/1/2023	2100H	0	0	0	0	340	300	250	500	1390
1/1/2023	2200H	0	0	0	0	300	300	250	500	1350
1/1/2023	2300H	0	0	0	0	300	300	250	500	1350
1/1/2023	2400H	0	0	0	0	290	300	250	500	1340
2/1/2023	0100H	0	0	0	0	290	300	250	500	1340
2/1/2023	0200H	0	0	0	0	310	300	250	590	1450
2/1/2023	0300H	0	0	0	0	200	300	250	450	1200
2/1/2023	0400H	0	0	0	0	180	300	250	450	1180
2/1/2023	0500H	0	0	0	0	190	300	250	450	1190
2/1/2023	0600H	0	0	0	0	190	300	250	350	1090
2/1/2023	0700H	0	0	0	0	200	300	250	350	1100
2/1/2023	0800H	0	0	0	0	215	300	250	400	1165
2/1/2023	0900H	0	0	0	0	230	300	250	400	1180
2/1/2023	1000H	0	0	0	0	235	300	250	450	1235
2/1/2023	1100H	0	0	0	0	260	300	250	450	1260
2/1/2023	1200H	0	0	0	0	230	300	250	450	1230
2/1/2023	1300H	0	0	0	0	210	300	250	450	1210

(1000Kwh / x 1000 Kwh) *Refer to Table 3*

	RESIDENCES	Port Vila	Luganville	Malekula	Tanna
YEAR	2018	56,923	6,940	685	993
	2019	66,035	10,477	1,053	1,413
	2020	60,821	9,828	1,009	1,401
	2021	53,447	11,172	835	1,161
	2022	62,873	11,169	1,033	1,367
	2023	57,304	10,808	1,165	1,463

Imports cleared for Home Consumption *Refer to Table 3*

		Petrol	Diesel	Kerosene
Year	2018	10271	54785	8
	2019	7924	38576	1857
	2020	12363	63614	7
	2021	14072	67023	96
	2022	8922	49805	1927
	2023	15914	78292	NA

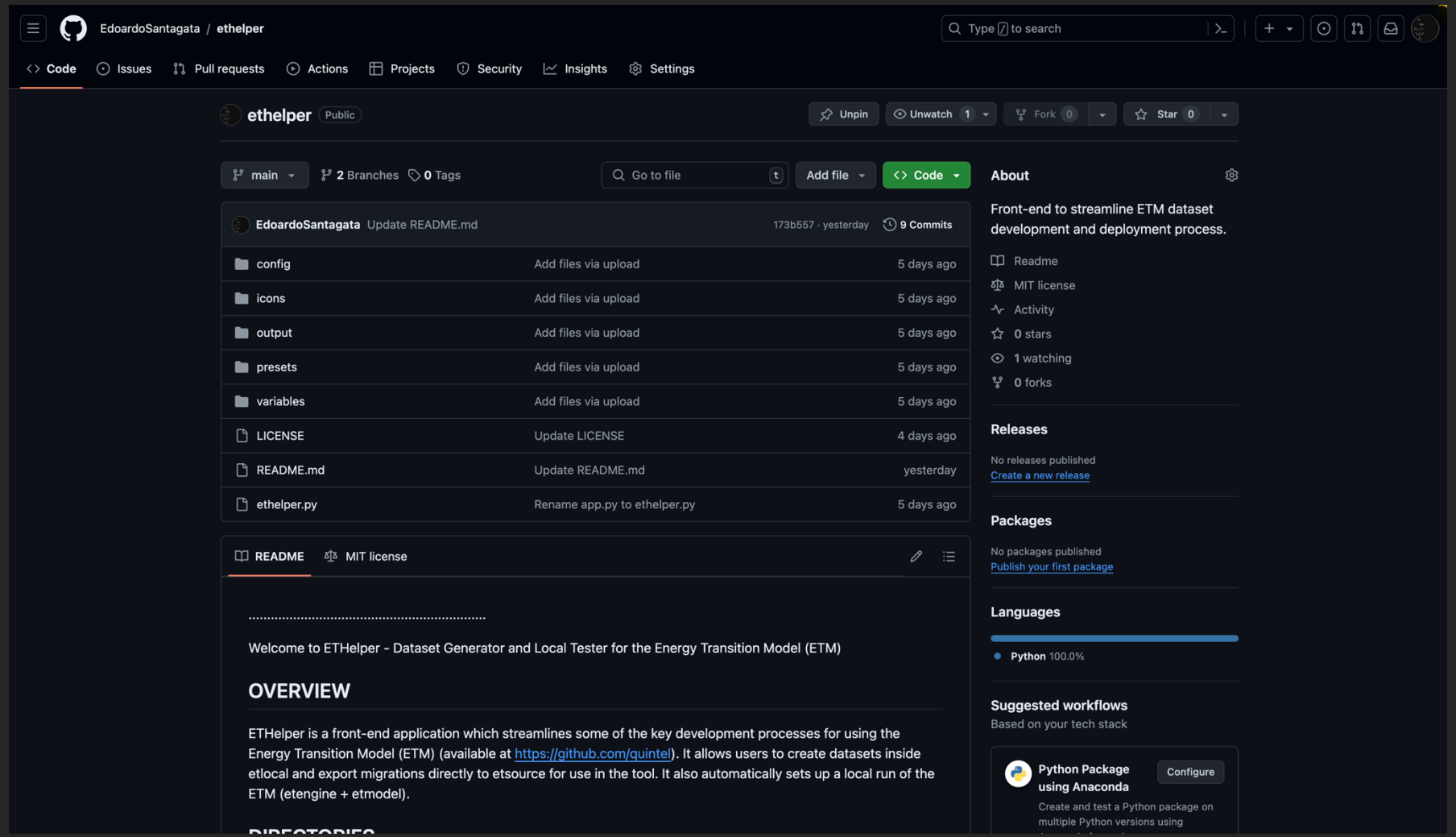
Imports Cleared for Home Consumption, in Value (In Millions vatu) *Refer to Table 6.6*

		Crude Materials ex	Mineral Fuels	Oil, fats & Wa	Basic manufac	Machines and Transport Equipment
Year	2018	2510	4888	148	5074	9742
	2019	707	5359	147	4983	8503
	2020	637	2946	133	4801	7068
	2021	754	4198	219	5254	8579
	2022	445	7442	129	4391	7966
	2023	918	7382	244	6392	12984

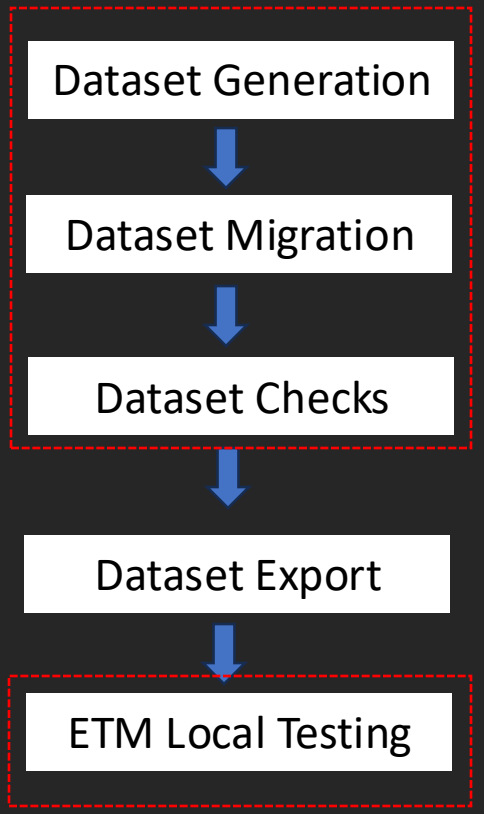
ETHELPER – DEPLOYMENT ASSISTANCE

Download on Github – https://github.com/EdoardoSantagata/ethelper

Key requirements: Python3, Internet Browser (Google Chrome, MS Edge, etc.)



Workflow



DISCUSSION QUESTIONS

What key multi-sectoral modelling outputs are crucial to inform decision-making and planning for utilities? How should these outputs travel across governance levels?

How can utilities improve data collection and information sharing? What sort of engagement exists with other energy-consuming economic sectors?

How important do you think a multi-sectoral approach is for the energy transition?

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Thank you!

Tankyu! Merci! Faafetai! Tubwa! Vinaka! Malo! Kom̧m̧ool! Whakawhetai ki a koe! Fakafetai fāfetai! Si Yu'os Ma'åse'!

Edoardo Santagata
edoardo.santagata@unsw.edu.au