Interreg CENTRAL EUROPE
PROSPECT2030
European Union
European Regional
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APE Agenzia Per l'Energia del Friuli Venezia Giulia
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Modelling regional energy systems using LEAP:

Carnia case study

LEAP

Long-range Energy Alternatives Planning System

Outline

Presentation outline:

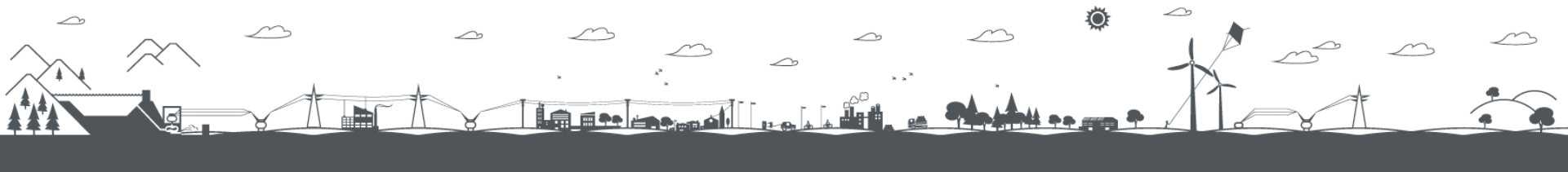
- LEAP modelling tool
  - Characteristics
  - Interface overview
  - Data input
  - Results display
- Carnia
  - Framework overview
  - Scenario approach
  - Energy balance and calibration
  - Results visualization

Modelling tool

LEAP

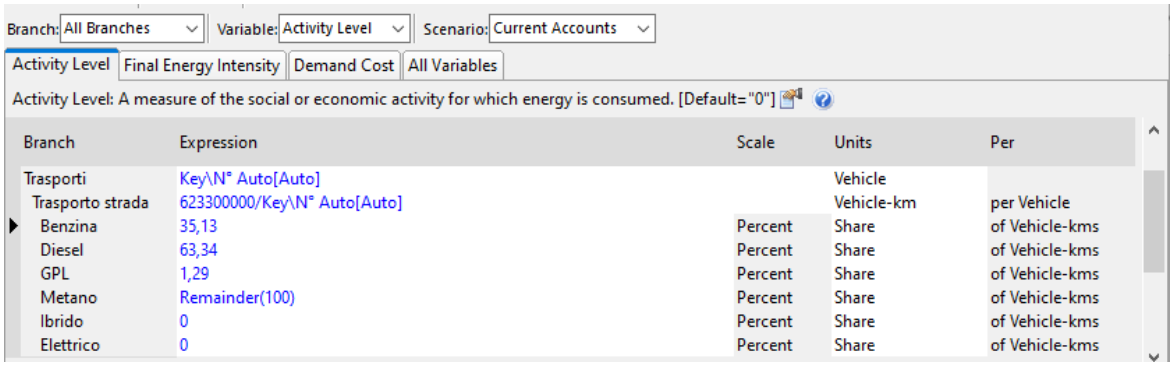
Long-range Energy Alternatives Planning System

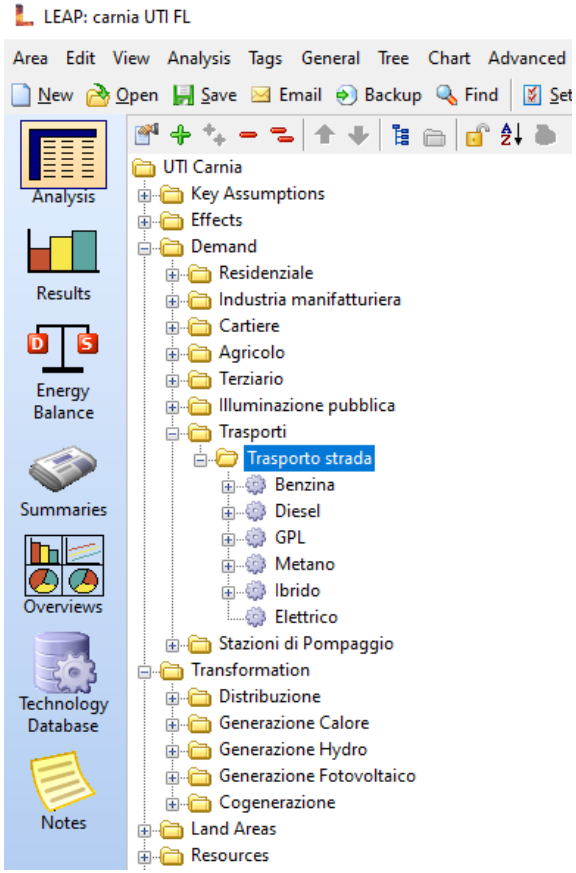
- Widely-used software tool for energy policy analysis, used at many different scales ranging from cities and states to national, regional and global applications;
- Scenario-based, can track energy consumption, production, resource extraction and GHG emissions within all economy sectors;
- Simulation and optimization for modelling electric generation and capacity expansion planning, with least-cost approach under user-input constraints;
- Medium to long term planning tool: calculations on an annual time-step, but allows to input profiles up to an hourly resolution;
- User-friendly graph visualization, Sankey diagrams and energy balance tables, with various sector and fuel type resolution.



Modelling tool

- Demand and transformation divided into branches and sub-branches, for each one technologies with relative fuel are specified;
- By selecting the branch is then possible to specify the values of all variables, input yearly profile shapes and dispatch rules, and specify future values for technology shares and efficiencies.

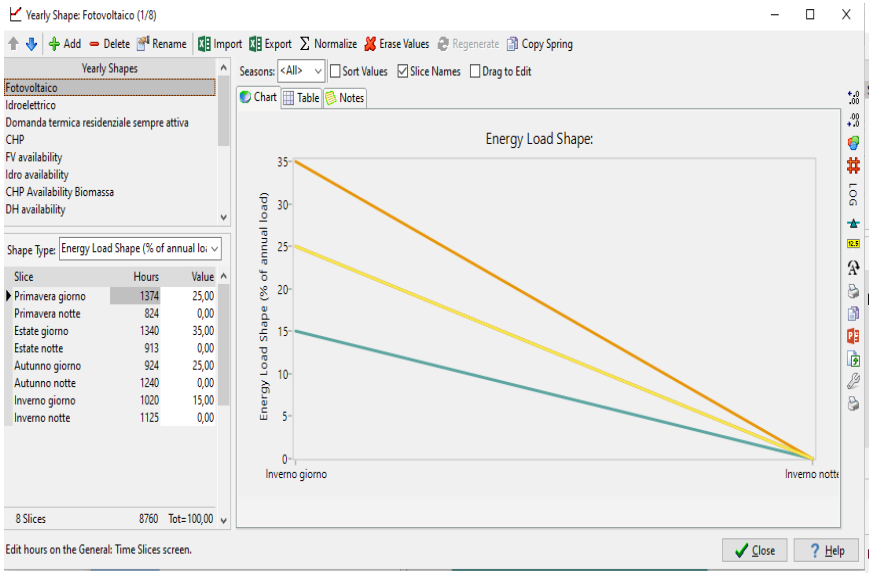


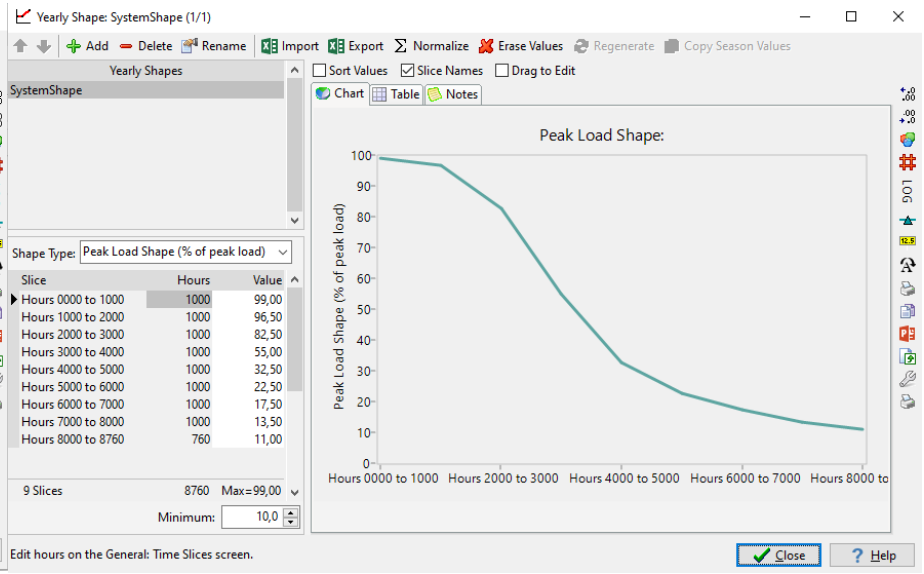


Modelling tool

- Profiles can have various time resolution and details, since LEAP allows different combinations of seasonal, weekday-weekend, night and day and hourly profiles;

- Can be written directly in LEAP or be imported from Excel;





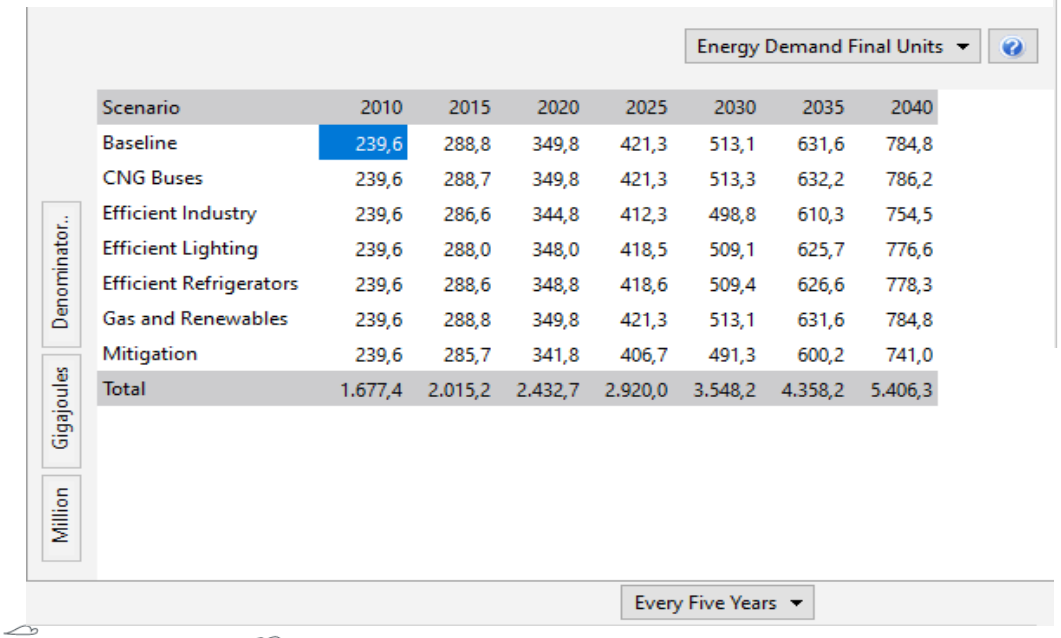
PV availability: 4 seasons and night&day profiles

Peak Load Shape: hourly aggregated into 9 slices

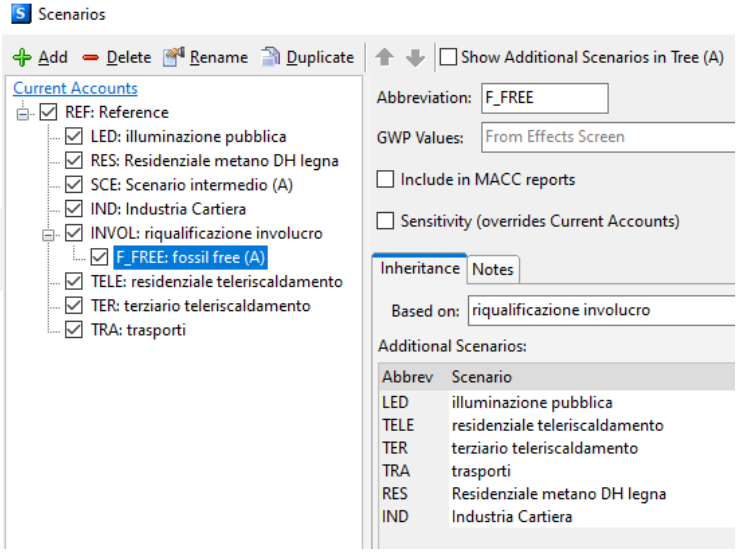
Modelling tool

- Multiple scenarios can be computed simultaneously, in such way it's possible to compare different measures and relative effects

- It also allows to combine different scenarios in order to analyse the synergy or overlapping of policies.



Scenario	2010	2015	2020	2025	2030	2035	2040
Baseline	239,6	288,8	349,8	421,3	513,1	631,6	784,8
CNG Buses	239,6	288,7	349,8	421,3	513,3	632,2	786,2
Efficient Industry	239,6	286,6	344,8	412,3	498,8	610,3	754,5
Efficient Lighting	239,6	288,0	348,0	418,5	509,1	625,7	776,6
Efficient Refrigerators	239,6	288,6	348,8	418,6	509,4	626,6	778,3
Gas and Renewables	239,6	288,8	349,8	421,3	513,1	631,6	784,8
Mitigation	239,6	285,7	341,8	406,7	491,3	600,2	741,0
Total	1.677,4	2.015,2	2.432,7	2.920,0	3.548,2	4.358,2	5.406,3



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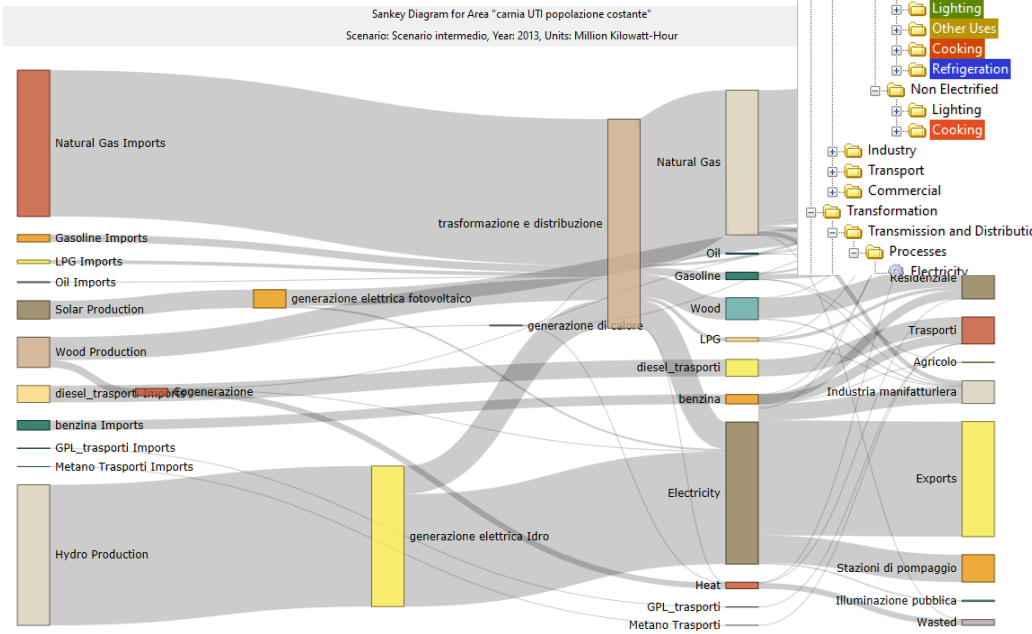
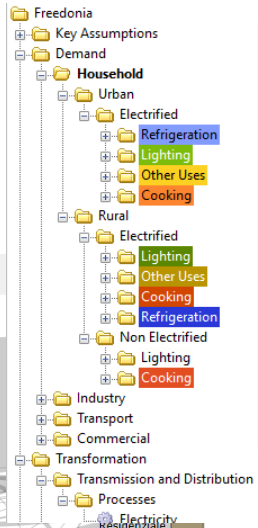
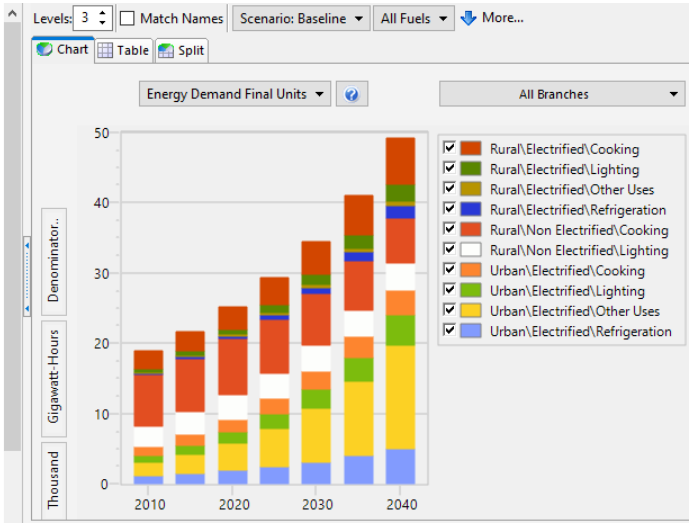
Modelling tool

LEAP allows to quickly visualize results by plotting several parameters, grouped by branch, fuel or scenario.







Besides that, it also offers Sankey diagrams and Energy Balance tables that can be exported in Excel.

Carnia framework

Within the framework that will bring to the publication of the Carnia Energy Plan, fundamental milestones are:

- Data gathering and compilation of the Energy Balance;
- Production of an Energy Model that accurately represents the different energy sectors at the current state of things and its calibration;
- Scenarios development;
- Result analysis, technical and also economic evaluation;
- Action proposals within the results guidelines.

OBJECTIVES OF CARNIA ENERGY PLAN

ENERGY SAVING
through energy saving measures

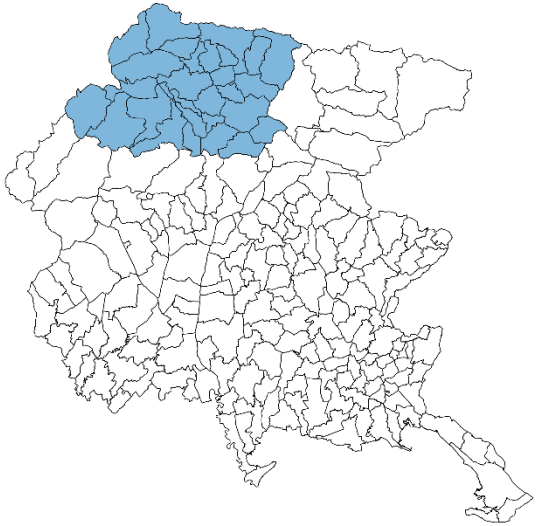
DEVELOPMENT OF RES
Increasing the presence and use of renewable energy sources

GHG EMISSION REDUCTION
through energy saving measures and use of RES

LOCAL DEVELOPMENT
Industrial and socio-economic growth.

Carnia framework

CARNIA



28 municipalities of
Friuli Venezia Giulia region

SECTORS

- RESIDENTIAL
- TERTIARY
- TRANSPORT
- INDUSTRY
- AGRICULTURAL

1.

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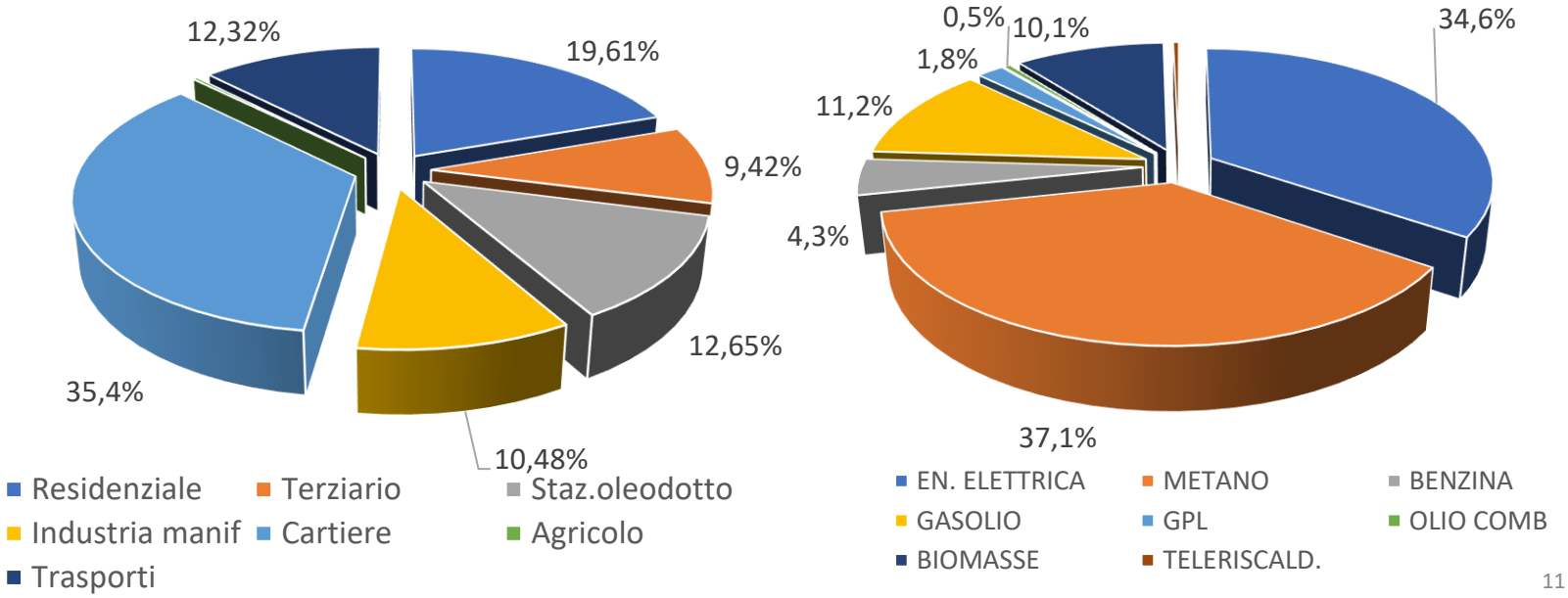
Carnia Energy Balance

- Paper Industry and pumping stations heavily affect the energy consumption;
- Methane is the largest energy vector, followed by electricity and oil products;
- Residential and transport will be the focus sectors for decarbonization.

2013 in tep by sector & fuel



Scenarios

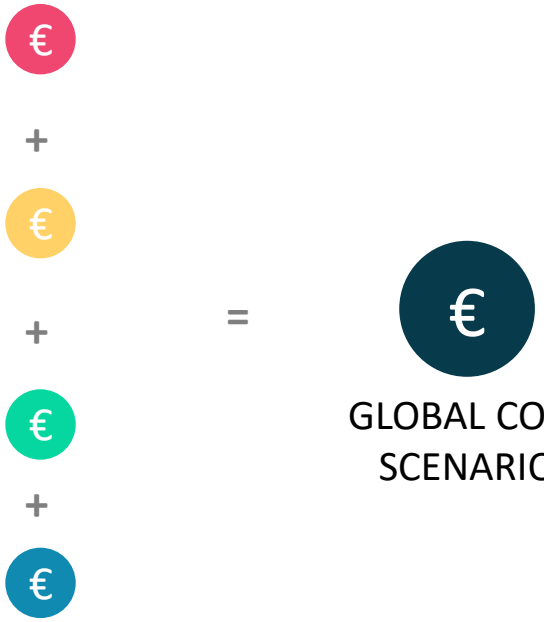
For two population development trends (constant and decreasing), two scenarios have been developed for 2050, combining different measures at different penetration levels.

	2. INTERMEDIATE	3. GREEN POLICY
RESIDENTIAL BUILDINGS	NG efficient boilers 30% biomass-fueled DH Remaining biomass efficient boilers	40% heat-pumps 40% biomass-fueled DH 20% biomass efficient boilers 100% energy savings coating
COMMERCIAL BUILDINGS	25% NG boilers 75% DH	25% NG boilers 75% DH
TRANSPORT	65% hybrid 35% electric	100% electric
PUBLIC LIGHTING	100% LED	100% LED
INDUSTRY	2022: -25% NG consumption Tolmezzo Paper plant	2022: -25% NG consumption Tolmezzo Paper plant

Considered costs

Considered costs:

- Fuel import costs;
- Demand cost: technology substitution costs for final energy use (e.g. car, boiler), annualized over its expected lifetime;
- Capital cost of new power plants, Fixed and Variable O&M;
- Externality costs: CO2 and PM10 emission costs.



Energy balance

Energy balance and model calibration: checking that Base Year reflects actual sectorial consumptions.

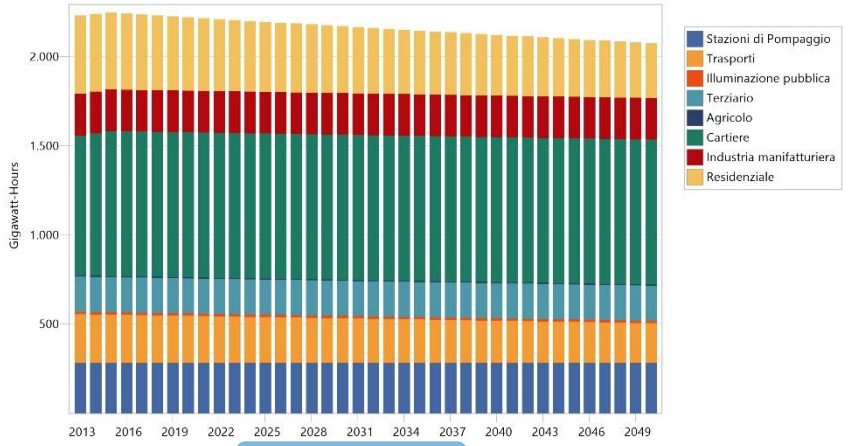
Energy Balance for Area "carnia UTI FL"

Scenario: Reference, Year: 2013, Units: Million Kilowatt-Hour

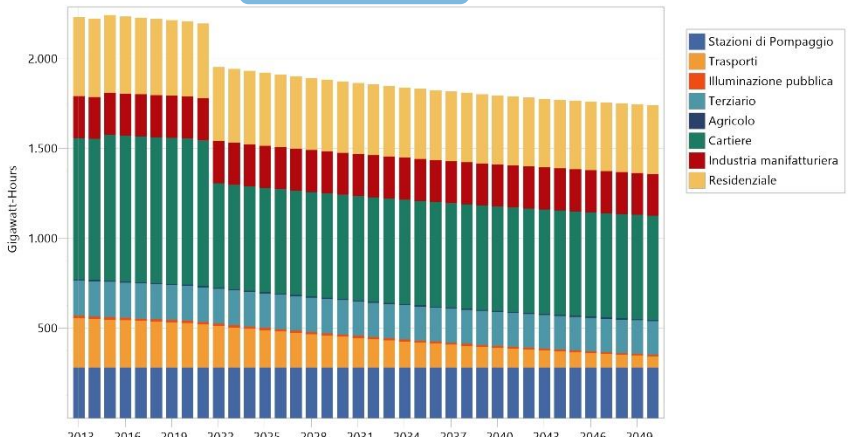
	Natural Gas	Hydropower	Renewables	Biomass	Electricity	Oil Products	Heat	Total
Production	-	1.447,9	187,7	311,8	-	-	-	1.947,4
Imports	836,5	-	-	-	-	398,8	-	1.235,3
Exports	-	-	-	-	-671,5	-	-	-671,5
Total Primary Supply	836,5	1.447,9	187,7	311,8	-671,5	398,8	-	2.511,2
Electricity Generation	-	-1.447,9	-187,7	-74,3	1.474,1	-	59,5	-176,4
Heat Generation	-	-	-	-10,9	-	-	8,2	-2,7
Distribution	-8,4	-	-	-	-32,1	-	-0,9	-41,4
Total Transformation	-8,4	-1.447,9	-187,7	-85,2	1.442,0	-	66,7	-220,5
Residenziale	51,3	-	-	208,8	90,9	85,6	1,4	438,0
Industria manifatturiera	44,8	-	-	13,8	172,2	3,1	-	233,9
Cartiere	687,3	-	-	-	99,0	-	-	786,3
Agricolo	-	-	-	-	3,7	2,8	-	6,4
Terziario	44,2	-	-	4,1	109,2	32,5	6,8	196,8
Illuminazione pubblica	-	-	-	-	13,5	-	-	13,5
Trasporti	0,5	-	-	-	-	274,8	-	275,3
Stazioni di Pompaggio	-	-	-	-	282,0	-	-	282,0
Total Demand	828,2	-	-	226,6	770,5	398,8	8,2	2.232,2
Unmet Requirements	-	-	-	0,0	0,0	-	-58,5	-58,5

Results

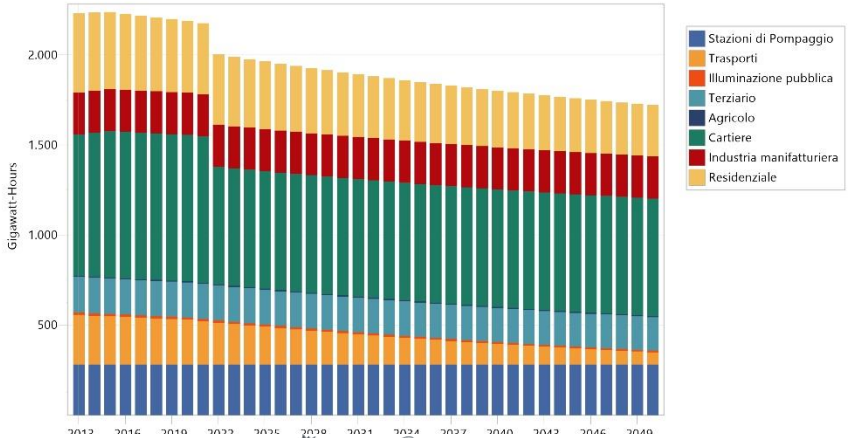
BAU



Intermediate



Green Policy

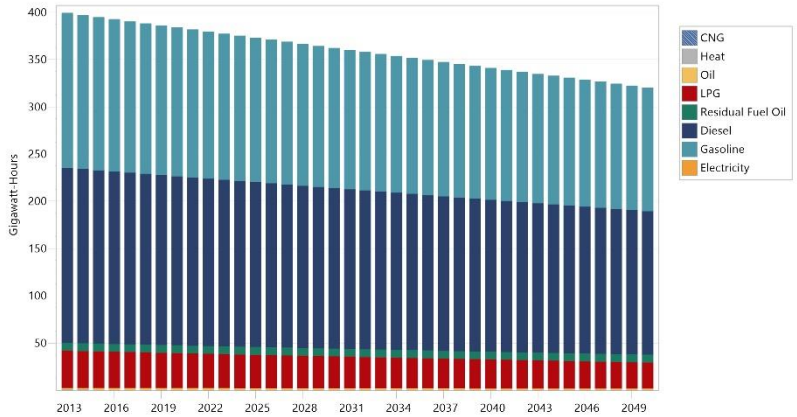


Final Energy Demand by sector:

- Reductions in residential and transport sectors
- Step reduction in industry sector in 2022
- Oil pipeline and other industries left unchanged

Results

BAU



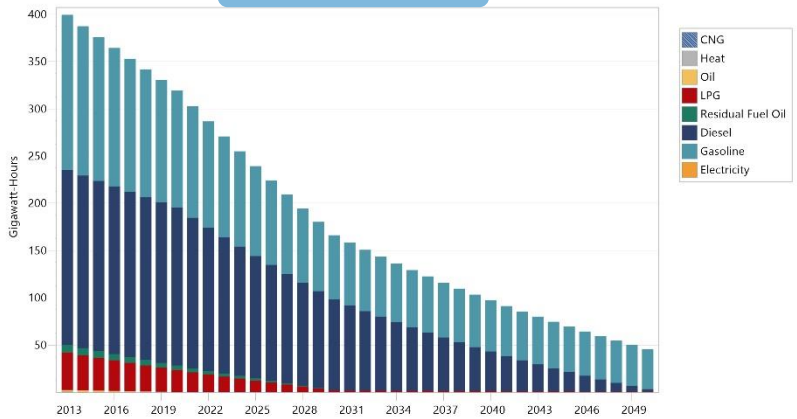
Primary fuel imports:

- 100% methane
- Dominated by industrial use

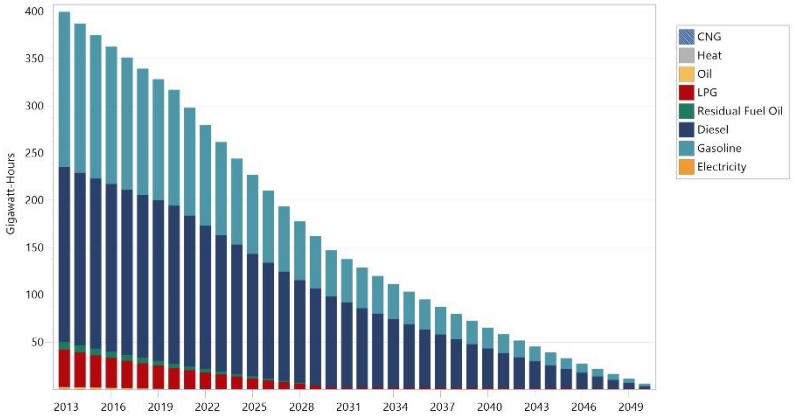
Secondary fuel imports (see graphs):

- 100% oil products
- Mainly for transport sector

Intermediate

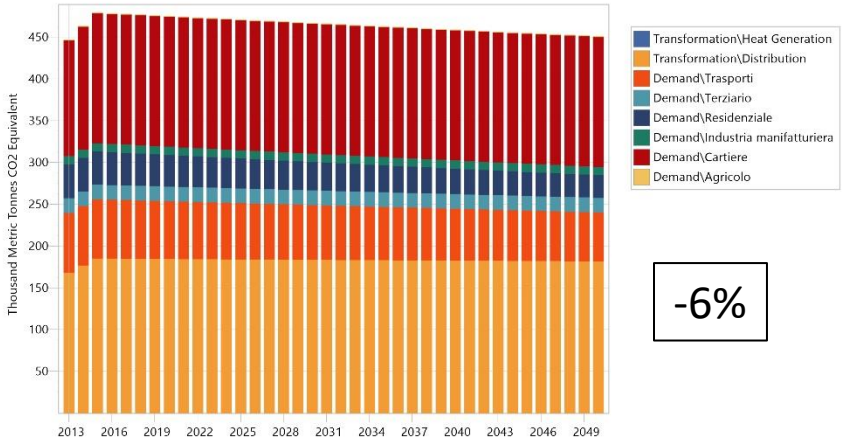


Green Policy



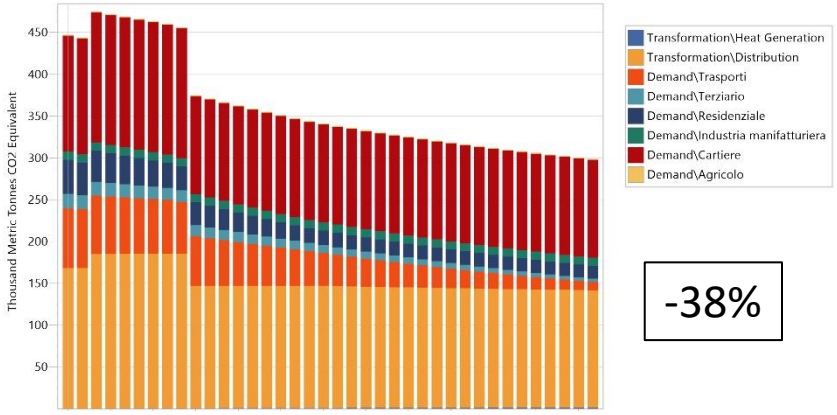
Results

BAU



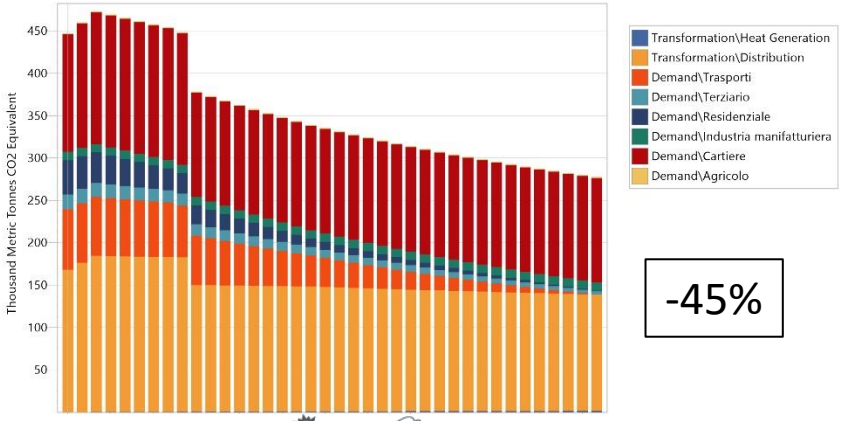
-6%

Intermediate



-38%

Green Policy



-45%

CO2 and PM10 emissions over decreasing population scenarios, with the only remaining emissions being industry-related.

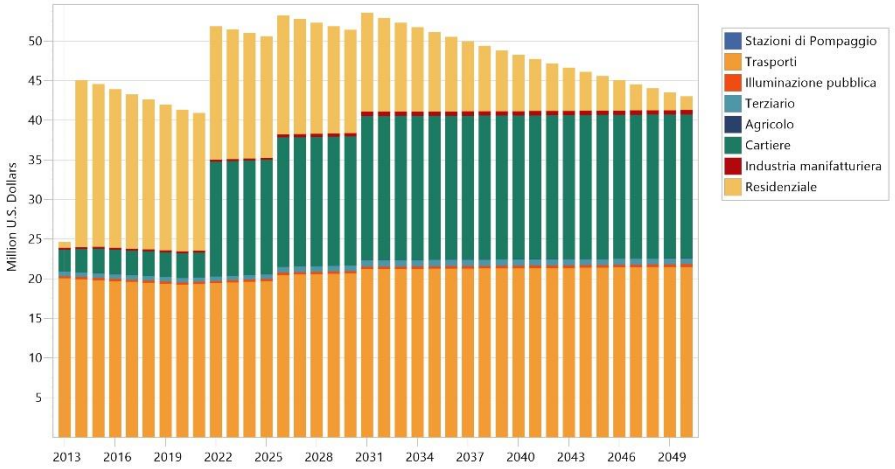
Results

Demand social costs are influenced mainly by investment costs on:

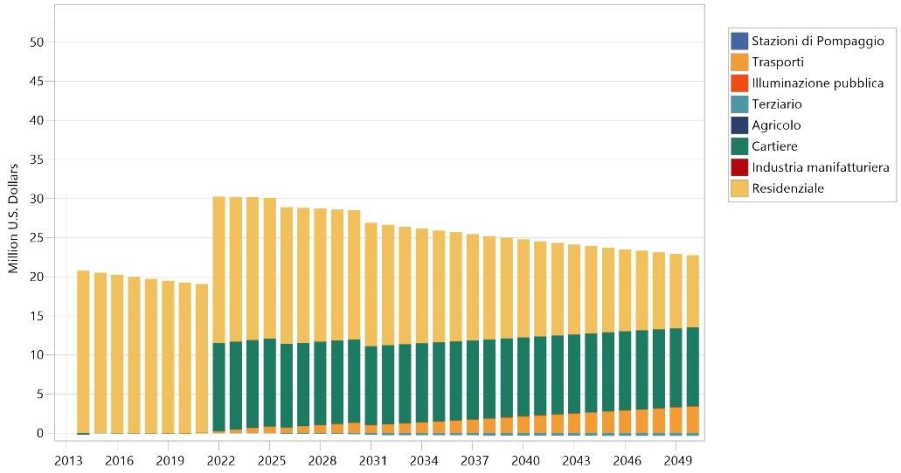
- Building coatings;
- Electric vehicles;
- Paper industry externalities.

Green Policy

Absolute values



Vs BAU



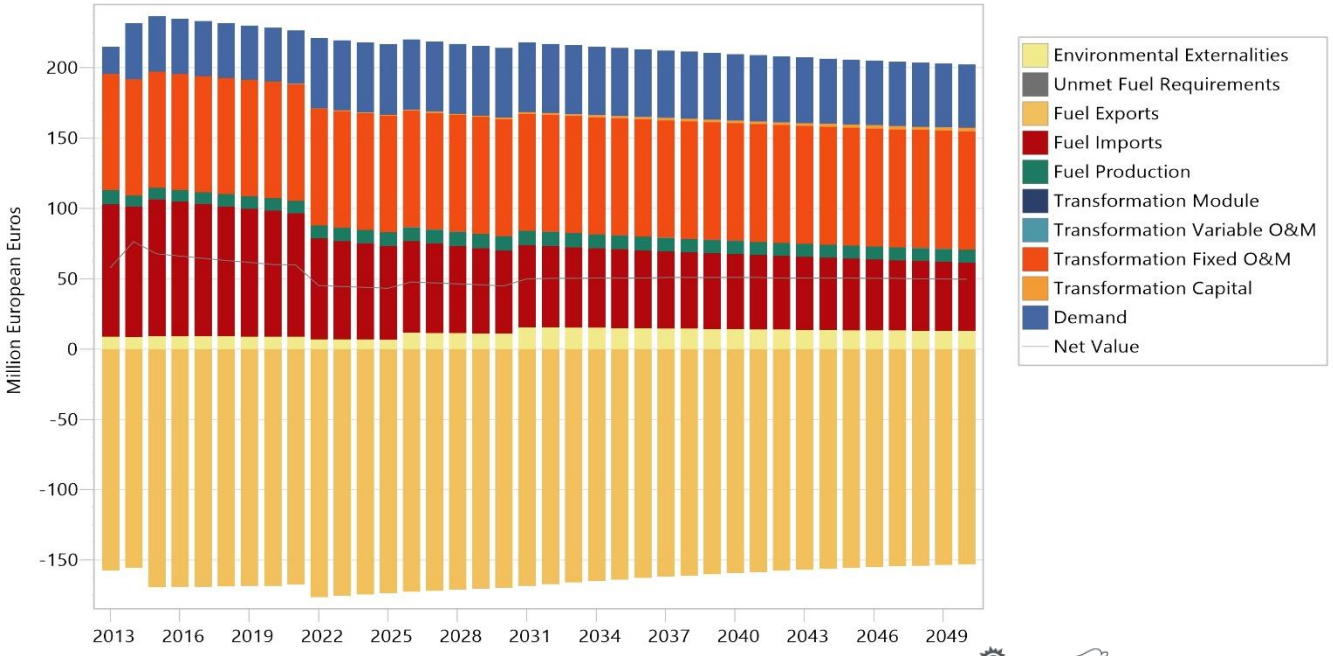
LEAP allows to plot the comparison between two different scenarios!

Results

Total social costs allow to visualize together:

- Demand costs;
- Import & Export costs;
- Transformation CAPEX and OPEX;
- Environmental costs.

Green Policy



CONCLUSIONS

Summarizing:

- LEAP is a powerful tool, suitable for current energy system analisys and long-term energy planning, not intended for operational optimization;
- Allows different levels of modelling accuracy, depending also on the availability of data;
- Scenario based, compares and combines different scenario measures, with quick and intuitive results visualization;
- Within the Carnia Energy Plan, it allowed to simulate different development projections and to provide useful guidelines for measures adoption.

Q&A