RENEWABLE ENERGY TECHNOLOGIES - ECONOMIC ANALYSIS TOOL (RET-EAT) FOR TURKEY

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INTRODUCTION

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- **General Overview of Turkey**
- **Energy Overview of Turkey**
- **Promoting Energy Efficiency in Buildings Project**
  - **Renewable energy technologies - economic analysis tool**
- **Conclusion**

GENERAL OVERVIEW OF TURKEY

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- The population of Turkey is **79,8 million** by end of 2016 and has been increasing gradually (about **1.3% per year**) each year.
- The average growth rate of GDP for the period 2000-2016 was around **4,3 %**
- GDP per capita is **10,936 USD**, Economic growth by **4 %** , Inflation rate **8.8 %** in 2015
- Annual Exports of **142.6 USD billion**, Annual Imports of **198.6 USD billion** in 2016
- Energy import dependency : **75,9 %**
  (Total primary energy consumption of Turkey is **129,2 MTOE** by 2015)
- Electricity consumption in 2016 : **278,3 TWh**
- Annual demand increase of Turkey : **4,6%** since 1990
  (Annual demand increase of the EU: **1,6%**)

- Electricity demand to increase annually **2,2%** (low case scenario) or **3,4%** (high case scenario) until 2026
- Investment required more than **$ 100 bl**. in the area of energy infrastructure for the next 10 years

ENERGY OVERVIEW

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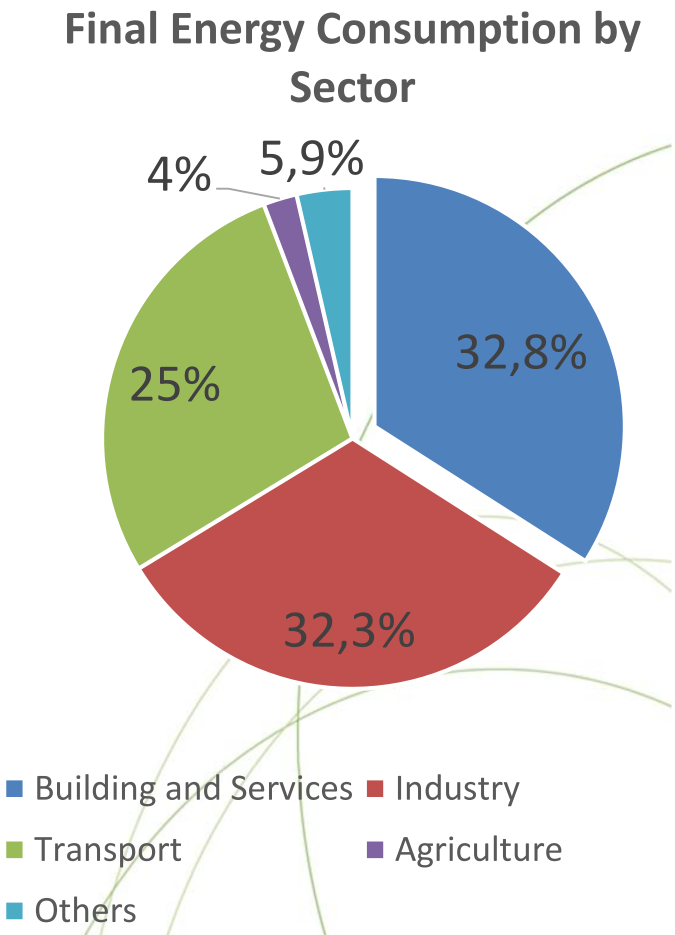
- Total **Primary** Energy Consumption in 2015

  129,2 Million TOE
- Total **Final** Energy Consumption in 2015

  98,9 Million TOE

Building Sector

- As of 2016, there are **9,1 million buildings** of which **7,9 million residential** properties.
- More than **100.000 new buildings** are constructed **every year.**
- While the **urbanization rate** in Turkey was 64,9% in 2000, it was nearly **75% in 2015**.
- At least **one fourth of (1/4) building stock** in the year 2010 shall be made as **sustainable building** by the year 2023.



PROMOTING ENERGY EFFICIENCY IN BUILDINGS PROJECT

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➢ Objective :

- ✓ The objective of the project is to **reduce energy consumption and associated GHG emissions in buildings** in Turkey by raising building energy performance **standards**, improving enforcement of building **codes**, enhancing building energy management and introducing the use of an **integrated building design approach**.

➢ Project Partners :

- ✓ Ministry of Energy and Natural Resources, Ministry of Environment and Urbanization, Ministry of National Education, UNDP, Global Environment Facility.

➢ Main Outcomes :

- ✓ Adapting an Integrated Building Design Approach (IBDA) in Turkey and demonstrating the concept in three new buildings,
- ✓ Developing Minimum Building Energy Performance Standards (MBEPS),
- ✓ Upgrading the MBEPS by including nearly-Zero Energy Buildings (nZEB) requirements,
- ✓ Developing **Renewable Energy Technologies - Economic Analysis Tool (Ret-eat)** For Turkey.

RENEWABLE ENERGY TECHNOLOGIES - ECONOMIC ANALYSIS TOOL

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Legal Requirement:

- ✓ According to current regulation in Turkey, **renewable energy technologies and cogeneration system use** should be analysed for new buildings which are larger than **20.000 m²** and it should be implemented equal **at least % 10 of total construction cost.**

The Renewable Energy Technologies Economic Analysis Tool is developed to assist building designers and developers. The tool aims to demonstrate the feasibility and benefits of renewable energy technologies (RET) in a more quantitative and comparable manner by;

- ✓ Calculating the energy savings potential, economic and environmental benefits from RET for buildings,
- ✓ Calculating associated investment costs of the renewable energy technologies for economic analysis and also to check if it complies with the minimum investment costs of the current regulations and bylaws of Turkey,
- ✓ Comparing possible RET implementation scenarios and base building scenarios.

MODELLING METHODOLOGY AND SCOPE

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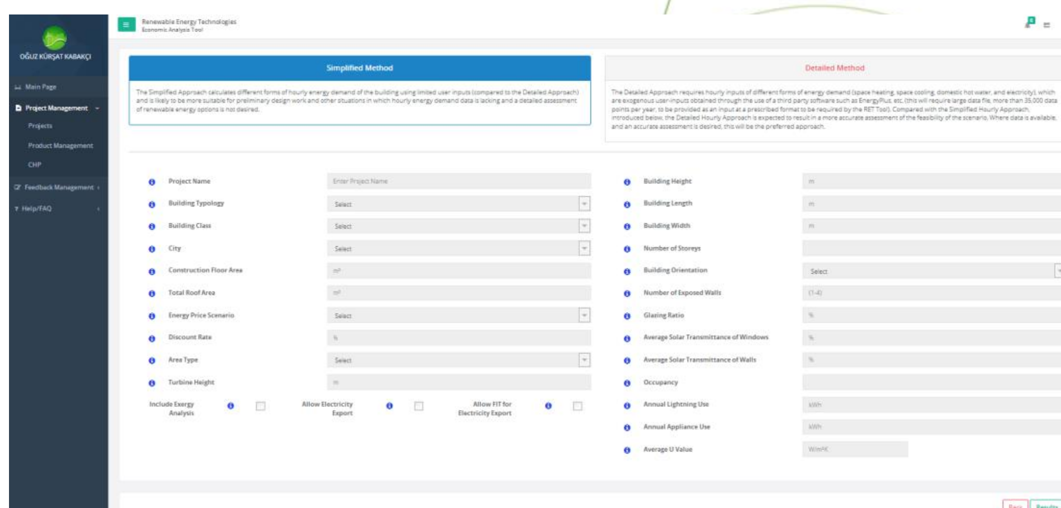
Two different calculation approaches with different data requirements are used in the tool:

- ✓ The Detailed Approach requires hourly inputs of different forms of energy demand (space heating, space cooling, domestic hot water, and electricity), which are exogenous user-inputs obtained through the **use of a third party software.**
- ✓ The Simplified Approach calculates different forms of hourly energy demand of the building **using limited user inputs** (compared to the Detailed Approach) and is likely to be more suitable for preliminary design work and other situations in which hourly energy demand data is lacking and a detailed assessment of renewable energy options is not desired.



MODELLING METHODOLOGY AND SCOPE

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The conventional and renewable energy technologies included in the model are as follows:

- Combined Heat and Power (CHP), including micro CHP and Combined cooling, Heating, and Power (Tri-generation) based on, turbine or engine,
- Heat pump,
- Heat driven chillers,
- Solar PV,
- Solar thermal,
- Solar PV-thermal,
- Wind Turbine
- Hot water storage,
- Cold water storage,
- Ice storage,
- Space heating storage
- Electricity storage (battery),
- Gas and biogas Boilers,
- Direct heat and hot water sources (e.g. geothermal, district heat or waste heat)

Scenario1 | Cost 3,261,825 TL | Capacity 4,510 kW | Storage 13,250 kWh

Technology	Product	Cost (TL)	Capacity (kW / kWh)
Wind turbine	Wind turbine - 1	400,000	50 (kW)
Photovoltaic	Solar PV - 1	250,000	50 (kW)
Solar Thermal	Solar thermal - 1	50,000	10 (kW)
Hot Water Storage	Hot water storage - 1	1,000	50 (kWh)
Cold Storage	Cold water storage - 1	260,000	13,000 (kWh)
Battery Storage	Battery storage - 1	100,000	200 (kWh)
Heat Pump	Heat pump - 1	300,000	150 (kW)
CHP	CHP - 1	750,000	600 (kW)
Absorbtion Machine	Absorbtion machine - 1	225,000	450 (kW)
Electric Chiller	Electric Chiller - 1	725,825	2,200 (kW)
Gas Boiler	Gas boiler - 1	200,000	1,000 (kW)

MODELLING METHODOLOGY AND SCOPE

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- 5 different scenarios can be defined by using any technologies.
- User can define additional technologies in database.

Scenario2 | **Cost 150,000 TL** | **Capacity 15 kW** | Add Product

Technology	Product	Cost (TL)	Capacity (kW / kWh)
Heat Pump	Toprak Kaynaklı Isı Pompası - 1	150,000	15 (kW)

Scenario3 | **Cost 1,000,000 TL** | **Capacity 950 kW** | Add Product

Technology	Product	Cost (TL)	Capacity (kW / kWh)
CHP	CHP - 4 (400 kWe / 430 kWt / 950 kW)	1,000,000	950 (kW)

Scenario4 | **Cost 300,000 TL** | **Capacity 100 kW** | Add Product

Technology	Product	Cost (TL)	Capacity (kW / kWh)
Photovoltaic	Panasonic HIT (0.325 kW)	300,000	100 (kW)

Scenario5 | **Cost 70,000 TL** | **Capacity 10 kW** | **Storage 165,000 kWh** | Add Product

Technology	Product	Cost (TL)	Capacity (kW / kWh)
Battery Storage	Battery storage - 2	25,000	5,000 (kWh)
Space Heating Storage	Space heating storage - 1	25,000	150,000 (kWh)
Hot Water Storage	Hot water storage - 1	5,000	10,000 (kWh)
Absorbtion Machine	Absorbtion machine - 1	15,000	10 (kW)

MODELLING METHODOLOGY AND SCOPE

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The detailed method or the simplified method is used to calculate the utilisation of user-selected technology mixes for each scenario and for the counterfactual "base" scenario. Based on these, the following metrics can be calculated.

- Annual energy demand met by the selected technology mix scenario
- Annual fuel savings (kWh) by the selected scenario including exergy analysis (optional)
- Annual CO_2 savings (tCO_2) by the selected scenario
- Energy efficiency of the system
- Rational Exergy Management Efficiency (optional)
- Increase in initial investment compared to baseline (% fraction of total building cost)
- Annual fuel/bill savings (TRY) by technology
- Payback duration by technology (years)
- Net annualised cost over lifetime by technology (TRY/y)
- Levelised cost of CO_2 reduction over lifetime by technology (TRY/tCO_2)
- Levelised cost of CO_2 reduction over project lifetime for building (TRY/tCO_2)
- Net present value of scenario

DATABASES

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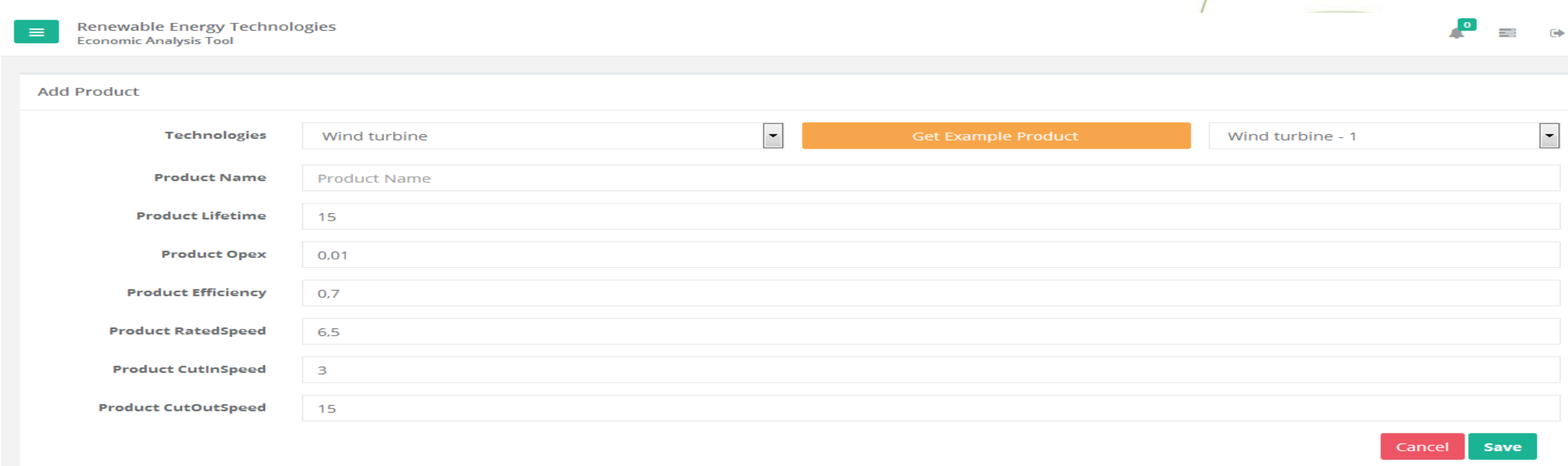
Key databases are as follows:

- D1: Meteorological database
- D2: Technology performance database
- D3: Base scenario system data
- D4: Fuel cost and CO_2 database
- D5: Technology costs database
- D6: Building unit cost database
- D7: Default building parameters database

Wind turbine

Lifetime	15	Opex	0.01	Efficiency	0.7
RatedSpeed	7	CutInSpeed	3	CutOutSpeed	15



SIMPLIFIED APPROACH

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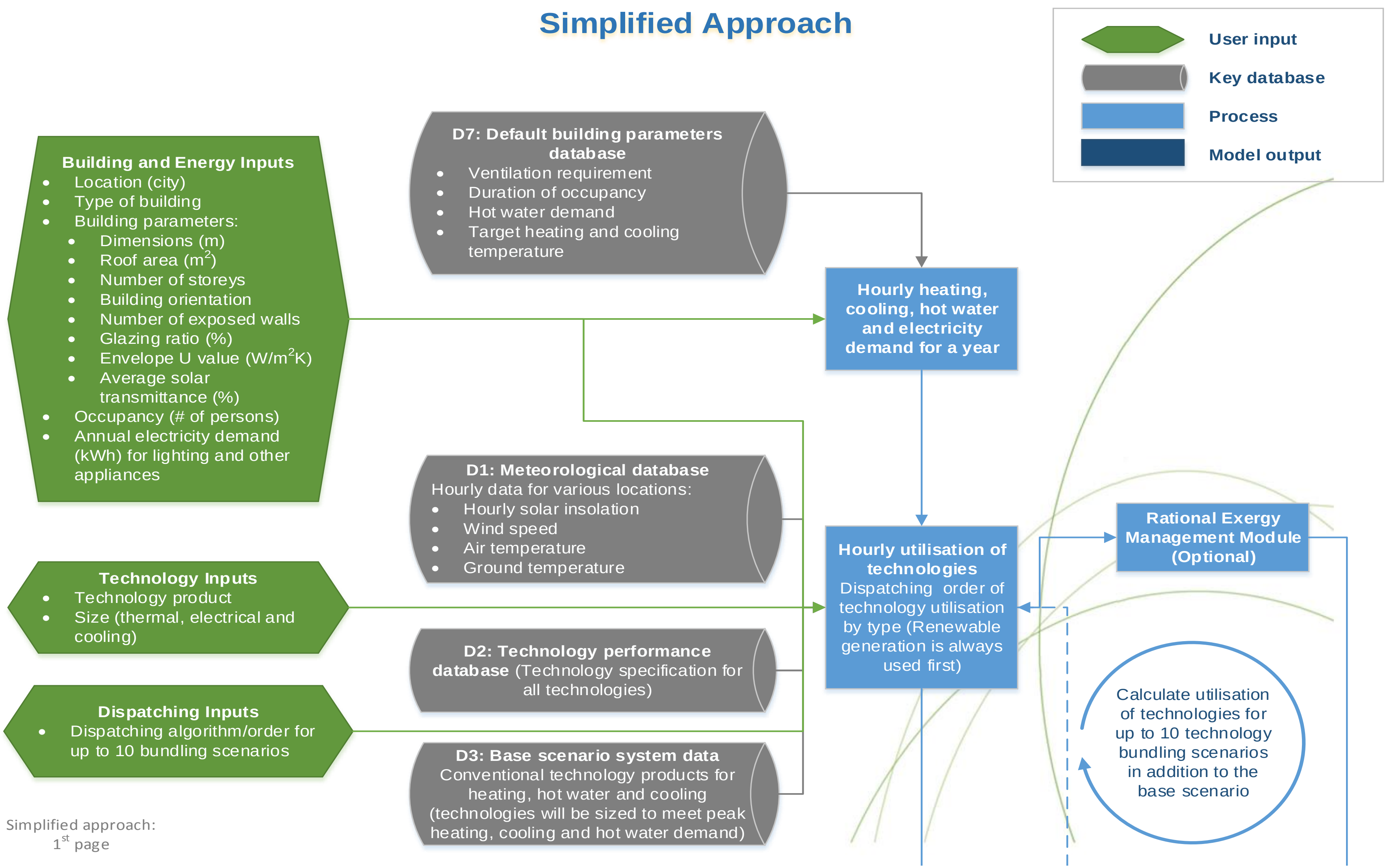

Simplified approach: 1st page

SIMPLIFIED APPROACH

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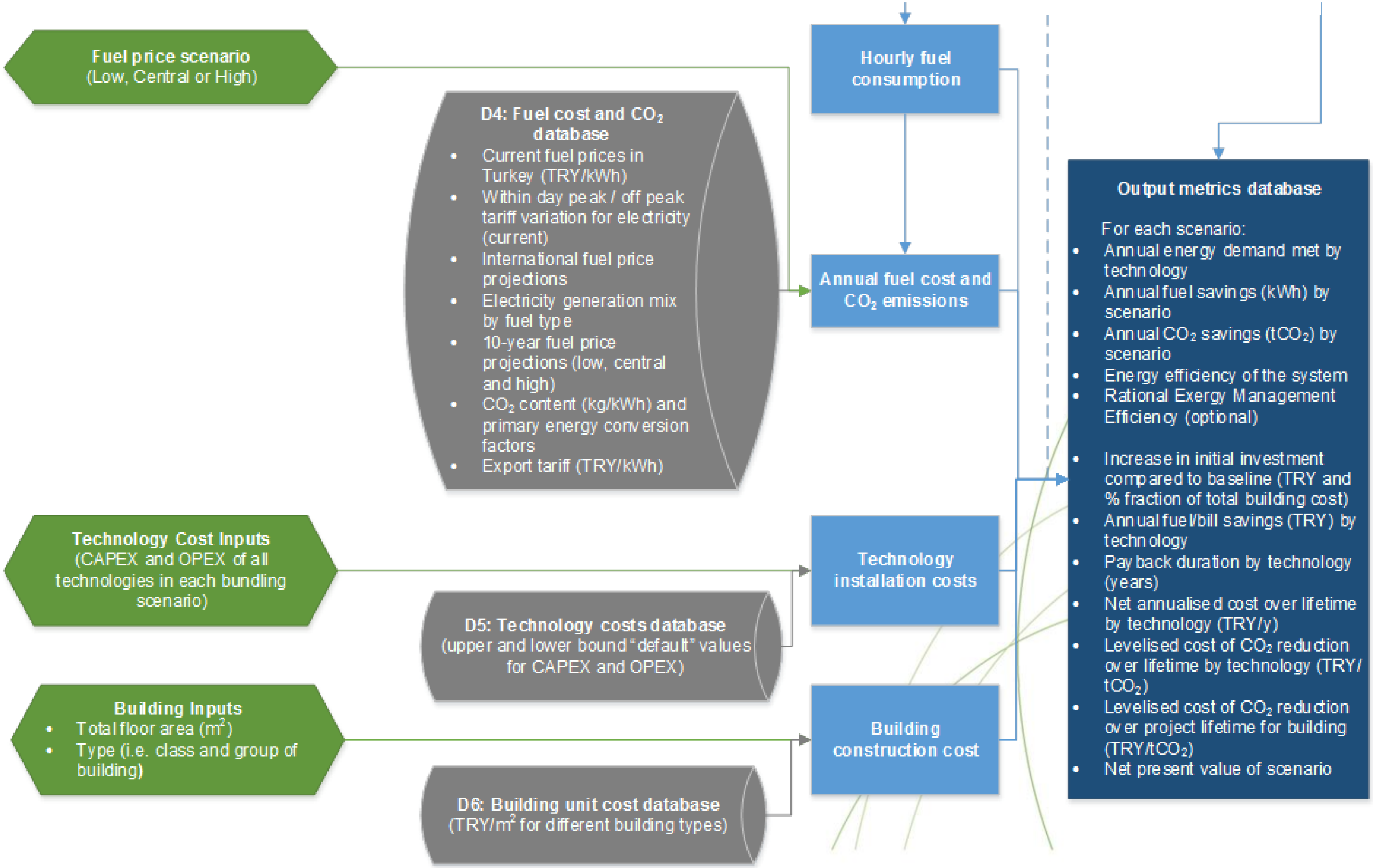

DETAILED APPROACH

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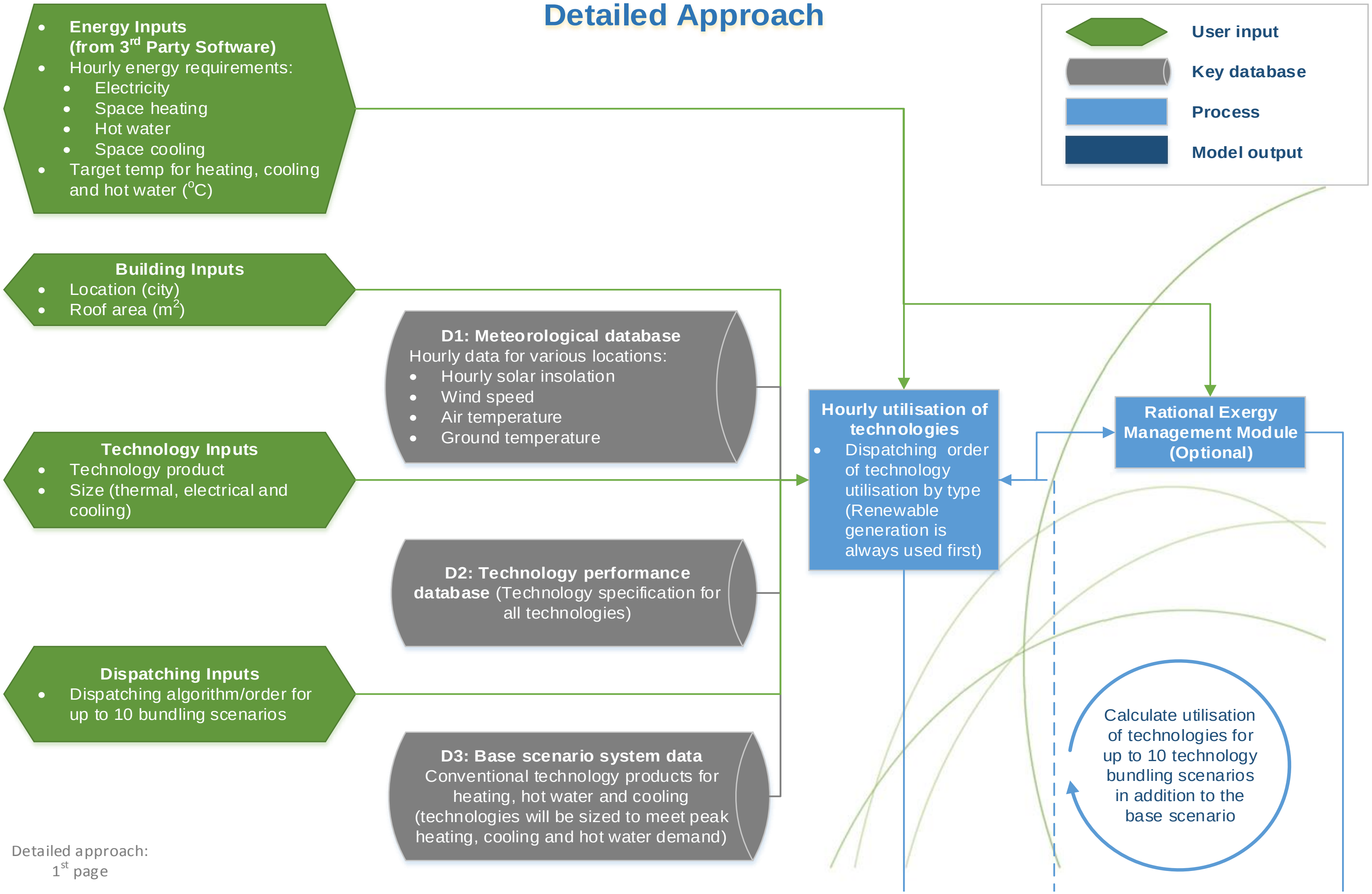
Detailed Approach



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DETAILED APPROACH

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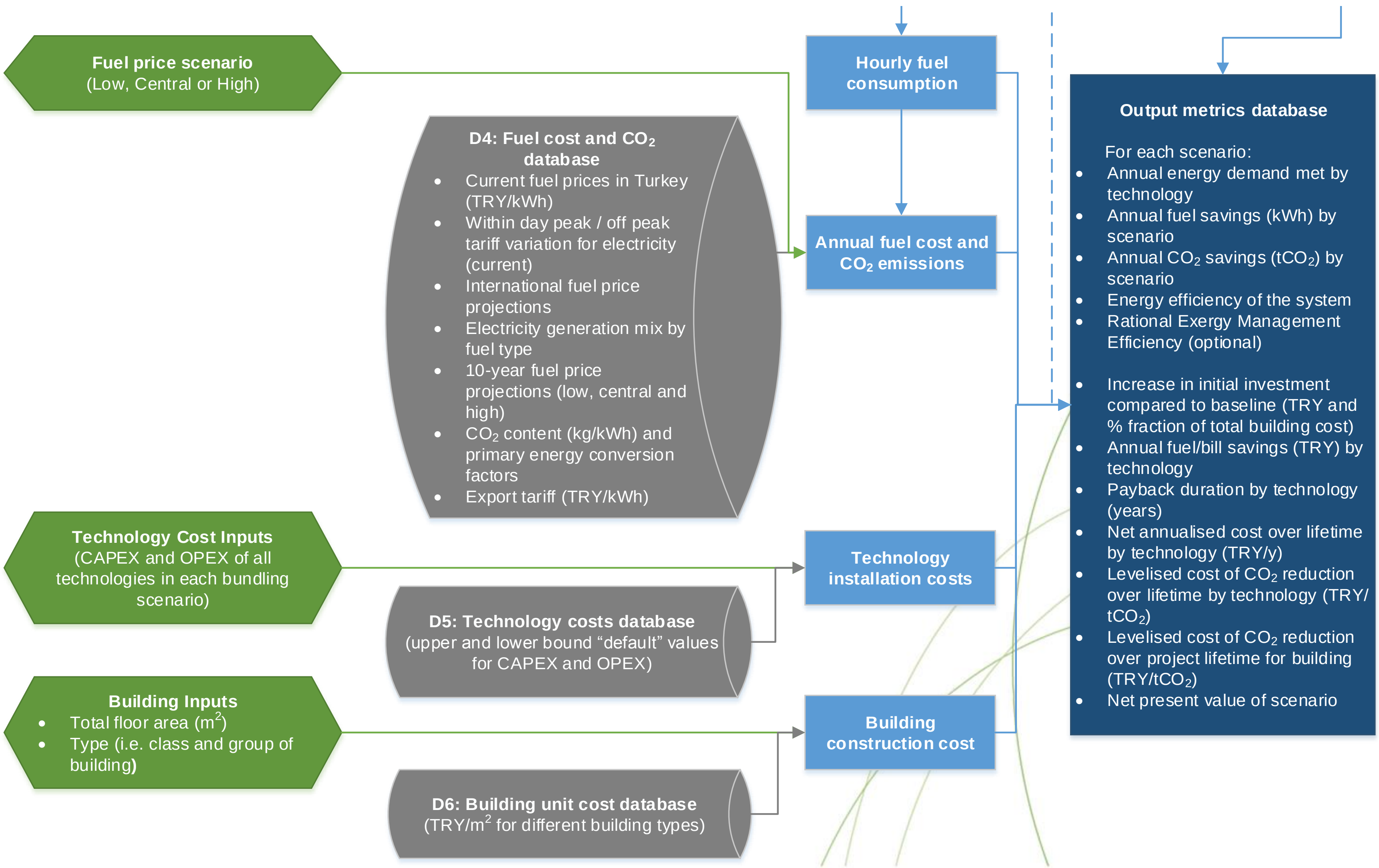

RESULTS SCREEN

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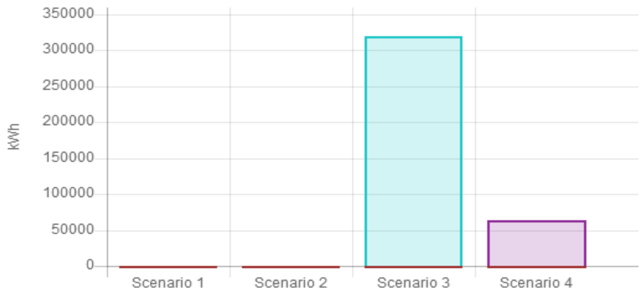
Summary Results

Conclusion	Scenario	Annual Primary Energy	Primary Energy Saving	CO_2 Saving	Total Cost	Payback Period	NPV	Exergy
★★★	Scenario 1	24,144.352	472,267.277	79,057.648	10,000.0	0.318	304,004.706	0.023
	Scenario 2	-98,352.405	594,764.034	79,057.648	150,000.0	10.312	-4,541.851	0.086
★★★	Scenario 3	94,061.952	402,349.677	-77,759.578	150,000.0	-6.685	-374,378.276	0.289
★	Scenario 4	-1,628,037.647	2,124,449.276	79,057.648	200,000.0	6.574	104,244.587	0.010

Space Heating

kWh	Scenario 1	Scenario 2	Scenario 3	Scenario 4
District Heating	0	0	0	0
Heat Pump	0	0	0	63,535
CHP	0	0	319,690	0
Biogas Boiler	0	0	0	0
Gas Boiler	0	0	0	0



	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Project Cost and Emission					
Total Building Cost (TRY)	2,950,000.0	2,960,000.0	3,100,000.0	3,100,000.0	3,150,000.0
Annual Operating Cost (TRY)	522.3	100.0	750.0	750.0	1,000.0
Annual Scenario Discounted Fuel Cost (TRY)	33,188.7	2,207.6	-16,295.8	55,399.2	2,287.3
Annual Scenario Emissions (tCO2e)	89.583	4.443	-18.097	13.823	-299.559
Annual Scenario Emissions Savings (tCO2e)	0.000	79,057.648	79,057.648	-77,759.578	79,057.648

CONCLUSION

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- RET-EAT methodology developed as a subpart of **“Promoting Energy Efficiency in Buildings in Turkey”** Project. National software will be obtained by using this methodology.
- This **web-based software** can be used as a decision support tool for designers and investors about the cost optimality of the renewable energy technologies.
- Renewable energy technologies **diversify the nation’s generation portfolio** away from fossil fuels.
- The magnitude of the renewable energy can play depends role on how much cost reduction projections materialize.
- Investments in renewable energy systems should result in comparable **reductions of investments** in traditional energy technologies.
- Although incorporating costly renewable resources into the generation portfolio mix might increase the expected costs, **fuel price risk is lower** and will offset by increased export of petroleum and less consumption of natural gas.
- Also, **exergy analysis** is a very useful tool which can be successfully used in the performance evaluation of renewable energy resources as well as all energy-related systems.

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THANK YOU

FOR

YOUR ATTENTION !

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