



# About the new version of Turkish MARKAL model

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# Supply Factors

- Changing energy balances;
- Security concerns over growing oil;
- Natural gas imports;
- Limited domestic energy resources other than coal and renewables;

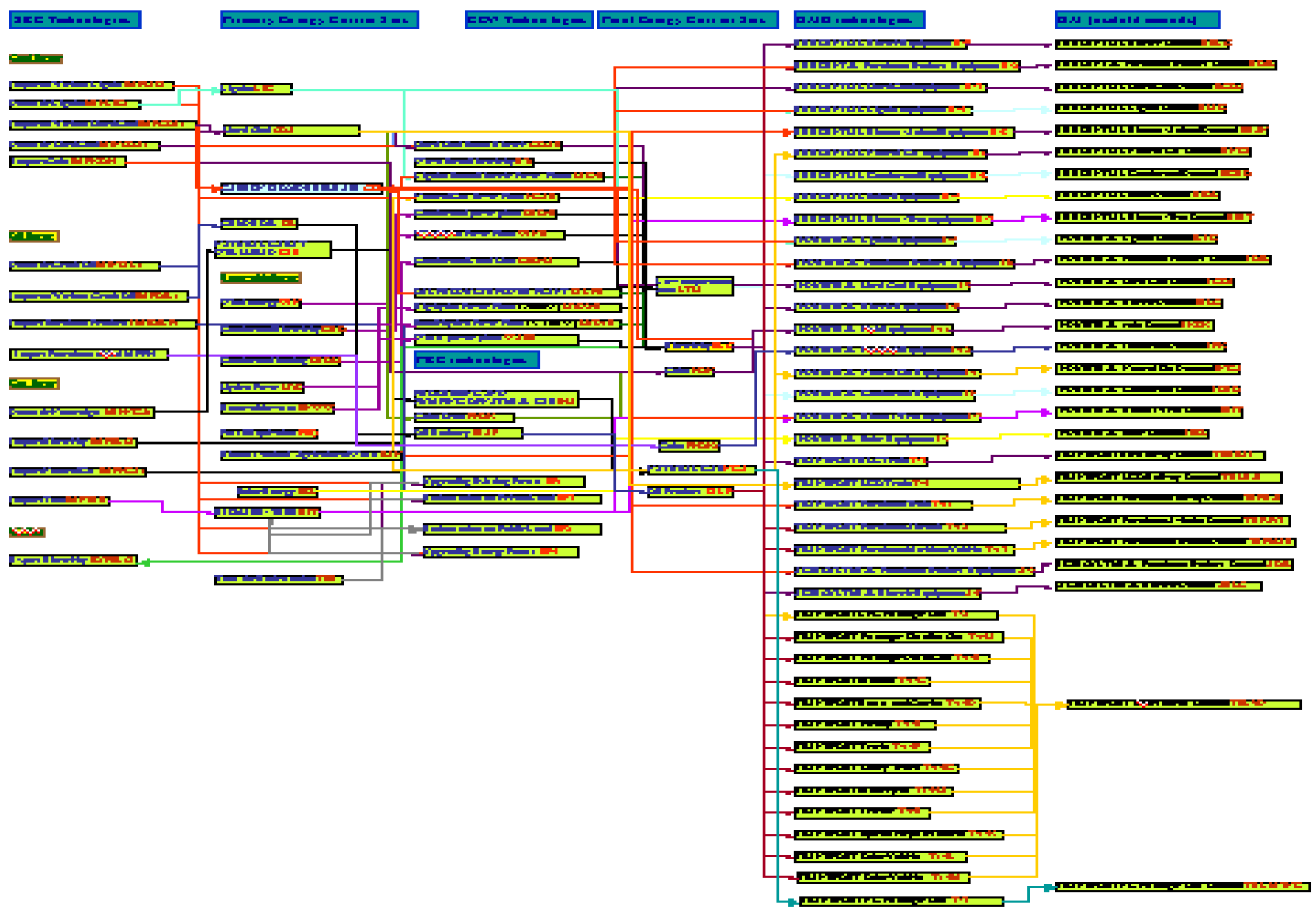
projected demands for energy that will exceed supply capabilities within a few years in Turkey.



# Turkish MARKAL Model

- Turkey is modeled as a single region because of the geographic largeness and complexity,
- Each period is set for 5 years,
- Analysis time period starts from year 2000, till 2020,
- Reference Energy System (RES) is constructed for the year 2000,

# REFERENCE ENERGY SYSTEM





# Turkish MARKAL Model

- **Industrial, residential, agricultural, and transport** sectors are identified,
- 15 Primary energy carriers, 14 resource technologies in use and might be available in (near) future, 7 process & 11 conversion technologies, 6 final energy carriers, 40 demand technologies and 28 of demands are determined,
- Their interactions and positions in MARKAL hierarchy are identified,





# Turkish MARKAL Model

- RES is identified with numerical data;
- Energy balance is constructed as a Base scenario,
- Base Scenario runs with optimal solution,
- Data is obtained from the official sources such as Ministry of Energy and Natural Resources and State Planning Organization for the future projections.



# ALL ENERGY CARRIERS

Scenario	Members	Region	Descriptions
BASE	BAN	REGION1	BIOMASS-ANIMAL AGRICULTURAL WASTE
BASE	BIT	REGION1	BIOMASS-TREE
BASE	COA	REGION1	HARD COAL
BASE	ELC	REGION1	ELECTRICITY
BASE	FEQ	REGION1	FOSSIL EQUIVALENT
BASE	GAS	REGION1	NATURAL GAS AT WELLHEAD
BASE	GEO	REGION1	GEO THERMAL FOR ELECTRICTY
BASE	GEOH	REGION1	GEO THERMAL FOR HEATING
BASE	HYD	REGION1	HYDRO POWER
BASE	KOK	REGION1	COKE
BASE	LIG	REGION1	LIGNITE
BASE	LTH	REGION1	LTH FOR GEO HEATING
BASE	NGA	REGION1	NATURAL GAS
BASE	OIL	REGION1	CRUDE OIL
BASE	OILP	REGION1	OIL PRODUCTS
BASE	PKOK1	REGION1	PETROCOKE
BASE	RNW-W	REGION1	RENEWABLE-WASTE
BASE	SOL	REGION1	SOLAR ENERGY
BASE	TRE	REGION1	TREES FOR REFORESTRATION
BASE	WIN	REGION1	WIND ENERGY



# All Technologies-1

Scenario	Members	Region	Descriptions
BASE	A-2	REGION1	AGRICULTURAL Petroleum Products Equipment
BASE	A-9	REGION1	AGRICULTURAL Electric Equipment
BASE	COA-E	REGION1	HARD COAL POWER PLANT
BASE	EXPELC1	REGION1	EXPORT ELECTRICITY
BASE	GEO-E	REGION1	GEOHERMAL - ELECTRICITY
BASE	GEO-H	REGION1	GEOHERMAL HEAT EXCHANGER CENTER
BASE	HYD1-E	REGION1	SMALL-HYDRO POWER PLANT ( <=10MW)
BASE	HYD2-E	REGION1	BIG-HYDRO POWER PLANT ( >10MW)
BASE	I-1	REGION1	INDUSTRIAL Natural Gas Equipment
BASE	I-11	REGION1	INDUSTRIAL Kok Equipment
BASE	I-12	REGION1	INDUSTRIAL Petrocoke Equipment
BASE	I-2	REGION1	INDUSTRIAL Petroleum Products Equipment
BASE	I-3	REGION1	INDUSTRIAL Hard Coal Equipment
BASE	I-4	REGION1	INDUSTRIAL Lignite Equipment
BASE	I-5	REGION1	INDUSTRIAL Solar Equipment
BASE	I-6	REGION1	INDUSTRIAL Geothermal Equipment
BASE	I-7	REGION1	INDUSTRIAL Biomass-Tree equipment
BASE	I-9	REGION1	INDUSTRIAL Electric Equipment





# All Technologies-2

<b>Scenario</b>	<b>Members</b>	<b>Region</b>	<b>Descriptions</b>
BASE	IMPCOA1	REGION1	IMPORT HARD COAL
BASE	IMPELC1	REGION1	IMPORT ELECTRICITY
BASE	IMPKOK1	REGION1	IMPORT COKE
BASE	IMPLIG1	REGION1	IMPORT LIGNITE
BASE	IMPNGA1	REGION1	IMPORT NATURAL GAS
BASE	IMPOIL1	REGION1	IMPORT CRUDE OIL
BASE	IMPOILP1	REGION1	IMPORT PETROLEUM PRODUCTS
BASE	IMPPK1	REGION1	IMPORT PETROCOKE
BASE	IMPTRE	REGION1	IMPORT TREE
BASE	LIG-E	REGION1	LIGNITE- POWER PLANT
BASE	MINCOA1	REGION1	HARD COAL MINE
BASE	MINLIG1	REGION1	LIGNITE MINE
BASE	MINNGA1	REGION1	GAS AT WELLHEAD
BASE	MINOIL1	REGION1	CRUDE OIL EXTRACTION
BASE	NGA-E	REGION1	NATURAL GAS POWER PLANT
BASE	OILP-E	REGION1	OIL PRODUCTS POWER PLANT
BASE	PKOK	REGION1	COKE OVEN



# All Technologies-3

## Scenario Members Region Descriptions

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BASE	PRAF	REGION1	REFINERY
BASE	R-1	REGION1	RESIDENTIAL Natural Gas equipment
BASE	R-2	REGION1	RESIDENTIAL Petroleum Products Equipment
BASE	R-3	REGION1	RESIDENTIAL Hard Coal equipment
BASE	R-4	REGION1	RESIDENTIAL Lignite equipment
BASE	R-5	REGION1	RESIDENTIAL Solar equipment
BASE	R-6	REGION1	RESIDENTIAL Geothermal Equipment
BASE	R-7	REGION1	RESIDENTIAL Biomass-Tree equipment
BASE	R-8	REGION1	RESIDENTIAL Biomass-Animal Equipment
BASE	R-9	REGION1	RESIDENTIAL Electric Equipment
BASE	S51	REGION1	PROCESSING AND PUMPING OF NATURAL GAS
BASE	SF1	REGION1	Upgrading Existing Forests
BASE	SF2	REGION1	Reforestration on Public Land
BASE	SF3	REGION1	Reforestration on Private Land
BASE	SF4	REGION1	Upgrading Energy Forests
BASE	T-11	REGION1	TRANSPORT PETROLEUM TRAIN



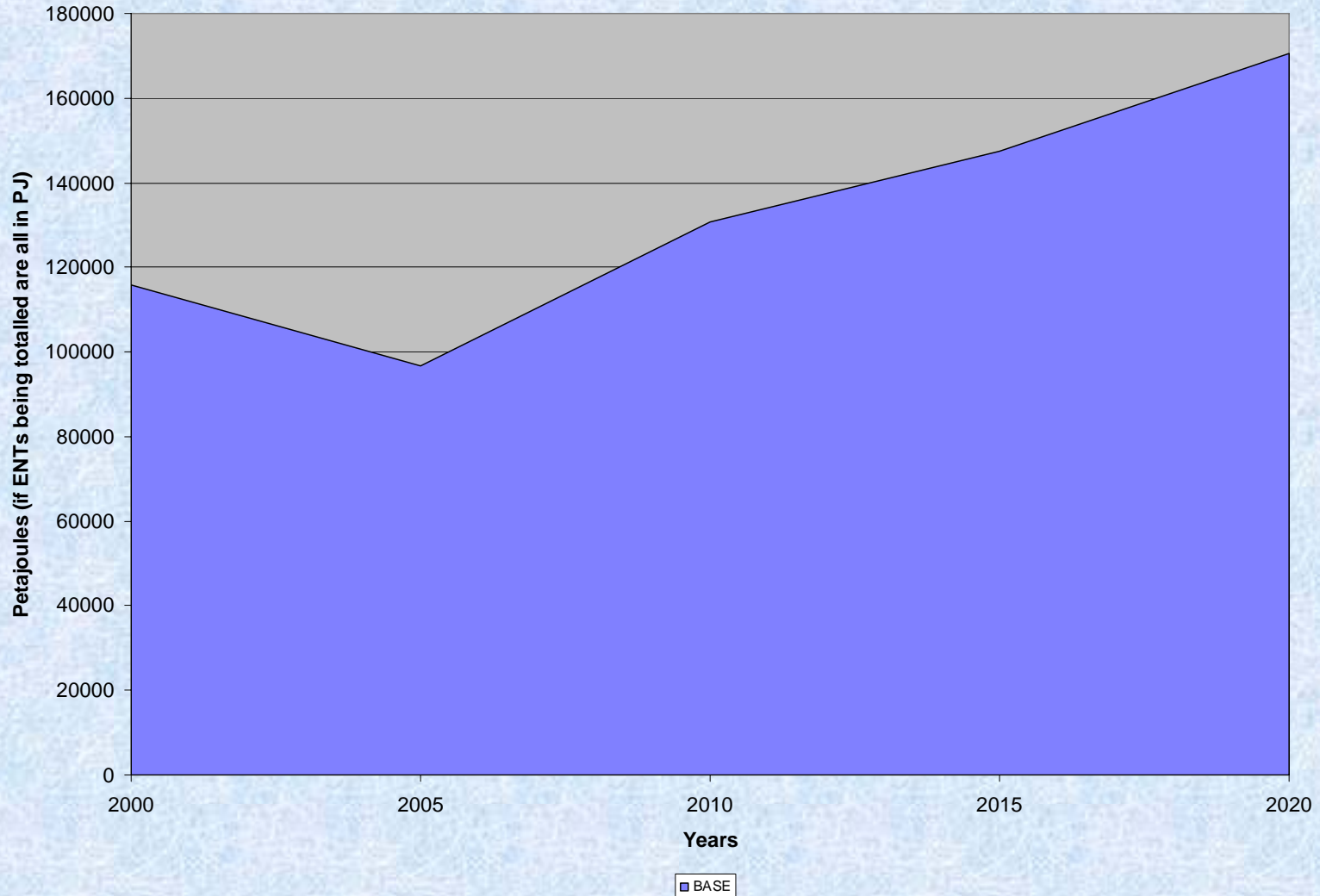
# All Technologies-4

<b>Scenario</b>	<b>Members</b>	<b>Region</b>	<b>Descriptions</b>
BASE	T-12	REGION1	TRANSPORT PETROLEUM AIRCRAFTS
BASE	T-13	REGION1	TRANSPORT Petroleum Maritime Vehicles
BASE	T-14A	REGION1	TRANSPORT Passenger Gasoline Cars
BASE	T-14B	REGION1	TRANSPORT Passenger Diesel Cars
BASE	T-14C	REGION1	TRANSPORT Minibus
BASE	T-14D	REGION1	TRANSPORT Buses and Coaches
BASE	T-14E	REGION1	TRANSPORT Pickups
BASE	T-14F	REGION1	TRANSPORT Trucks
BASE	T-14G	REGION1	TRANSPORT Heavy Trucks
BASE	T-14H	REGION1	TRANSPORT Motorcycles
BASE	T-14I	REGION1	TRANSPORT Tractor
BASE	T-14K	REGION1	TRANSPORT Special Purpose Vehicles
BASE	T-2	REGION1	TRANSPORT LPG Passenger Cars
BASE	T-3	REGION1	TRANSPORT ELC TRAIN
BASE	T-4	REGION1	TRANSPORT HCO TRAIN
BASE	T-5	REGION1	TRANSPORT CNG LAND VEHICLES
BASE	WAS-E	REGION1	WASTE - ELECTRICITY
BASE	WIN-E	REGION1	WIND FARM - ELECTRICITY





# Total Primary Energy : TURKEY

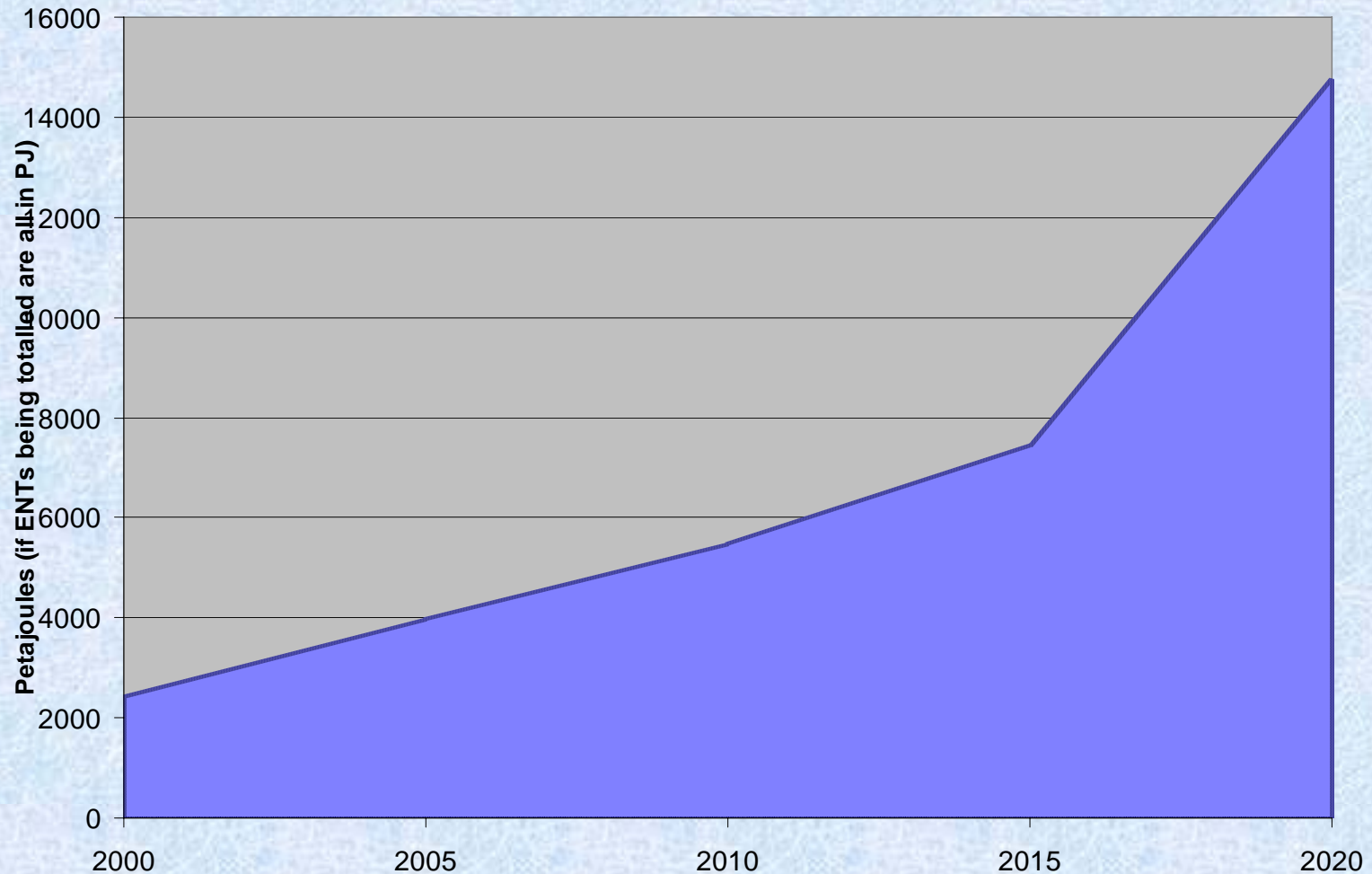






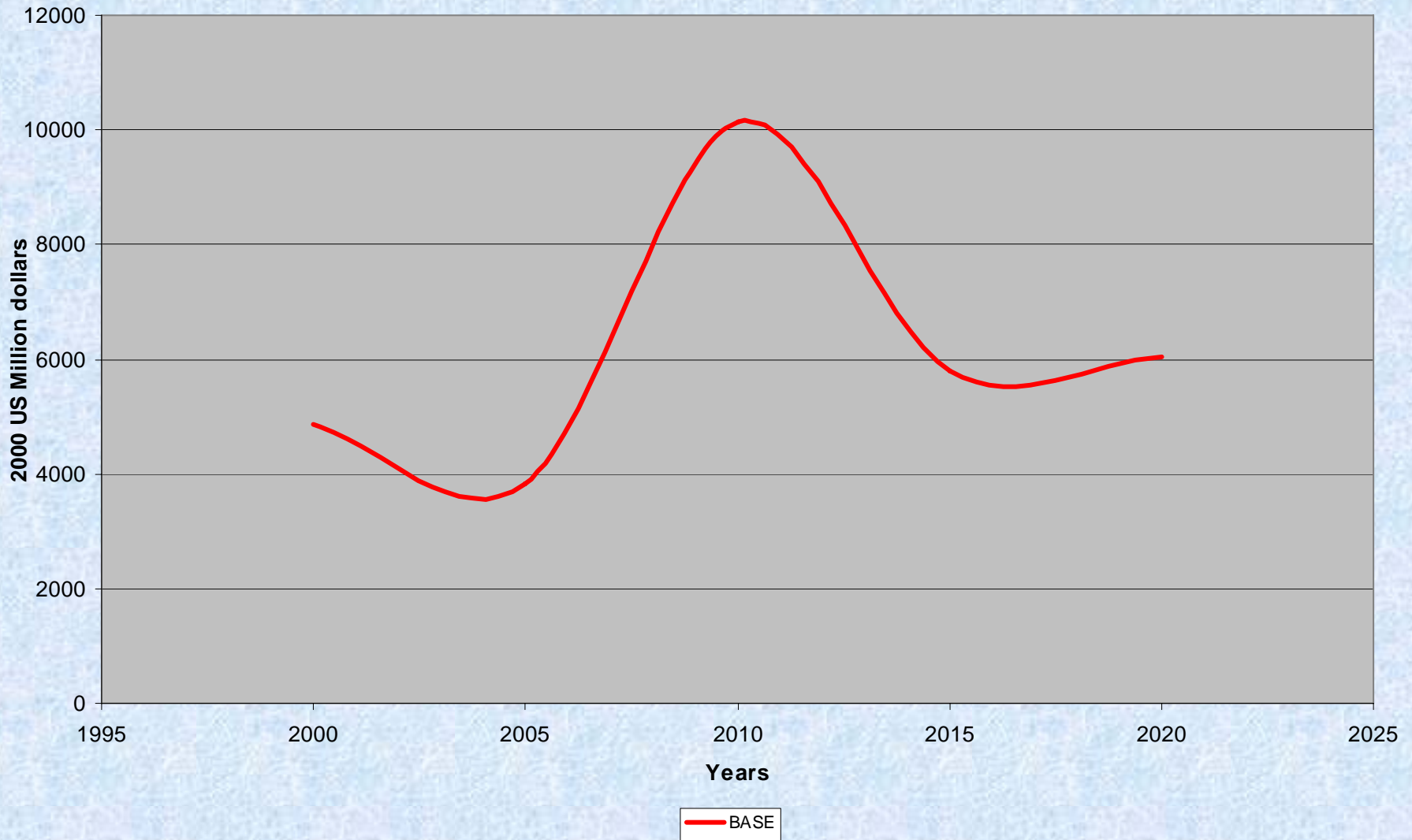
# RESULTS FROM BASE CASE

## Total Final Energy : TURKEY



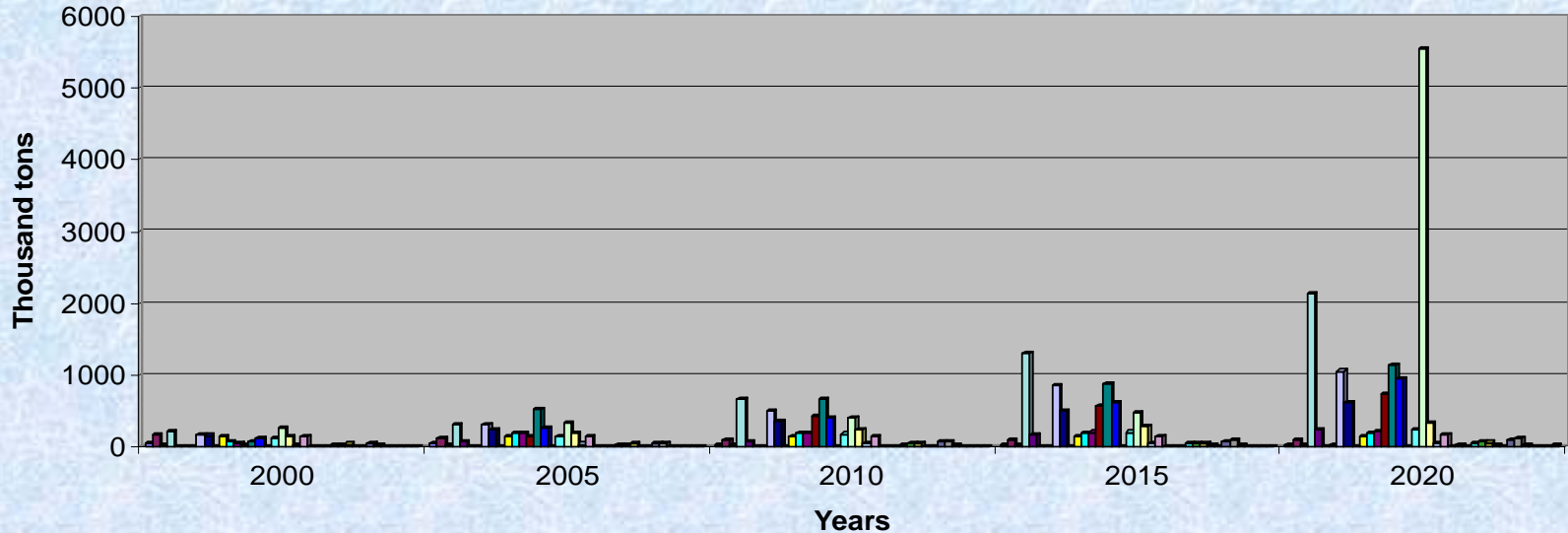


# Undiscounted Investment Total in Technologies





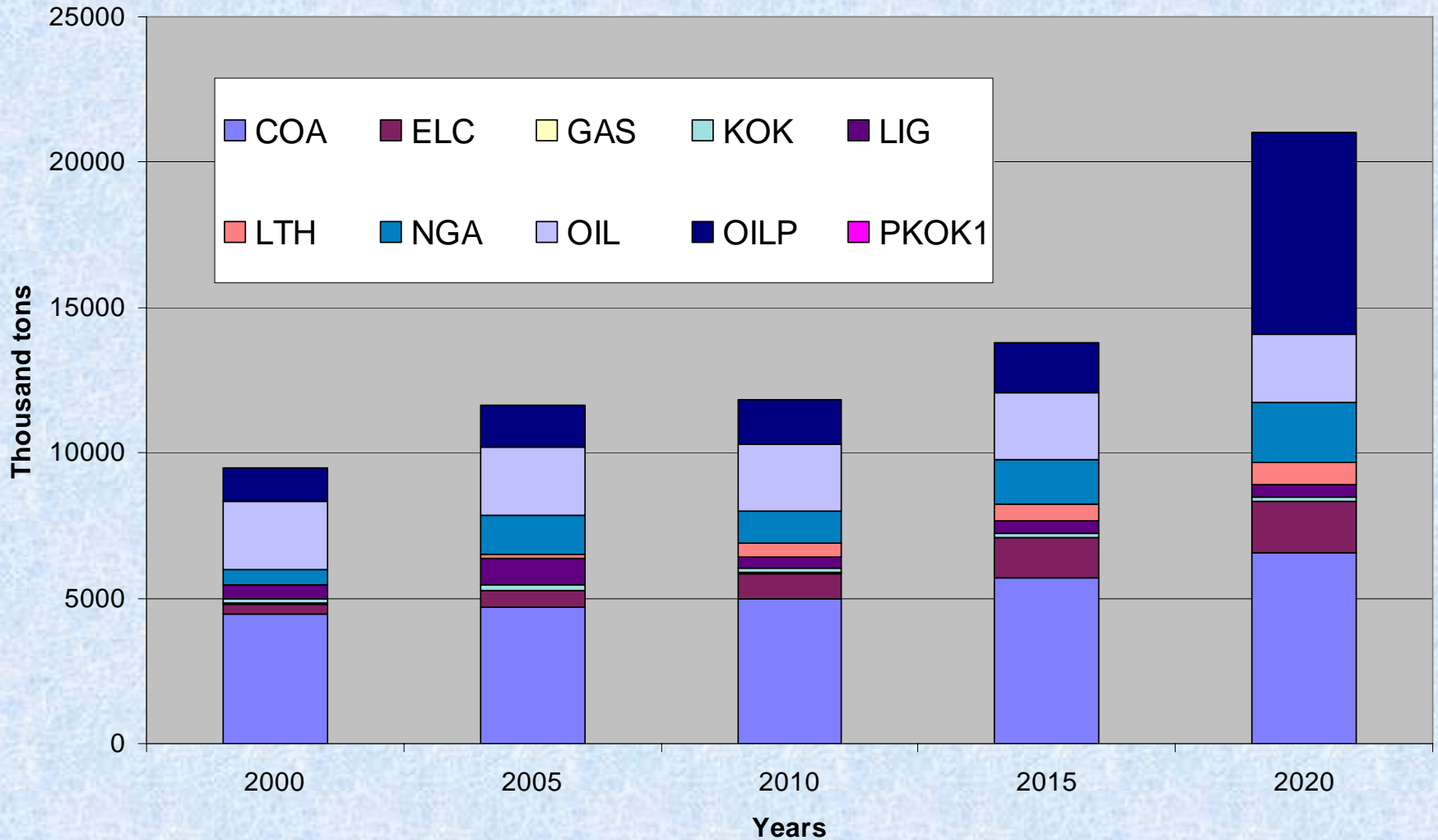
# Case Region: TURKEY, BASE: Fuel Consumption by Energy Carrier by End-Use Demand



BAN, RBAN	BIT, IBIT	BIT, RBIT	COA, ICOA
COA, RCOA	COA, TRHRAI	ELC, AELC	ELC, IELC
ELC, RELC	ELC, TRERAI	KOK, IKOK	LIG, ILIG
LIG, RLIG	LTH, RCEO	NGA, INGA	NGA, RNGA
NGA, TRNLAN	OILP, AOIL	OILP, IOIL	OILP, ROIL
OILP, TRLM1DSL	OILP, TRLM1GSL	OILP, TRLM1LPG	OILP, TRLM2DSL
OILP, TRLM3DSL	OILP, TRLMOTGSL	OILP, TRLN1DSL	OILP, TRLN2DSL
OILP, TRLN3DSL	OILP, TRLSPVDSL	OILP, TRLTRADSL	OILP, TRPAVI
OILP, TRPMAR	OILP, TRPRAI	PKOK1, IPK	SOL, ISOL
SOL, RSOL			



# Case Region: TURKEY, BASE: Use of Energy Carriers: Total All Technologies







# Emission Level (Total All Technologies) : TURKEY, CO<sub>2</sub>

