SEERMAP Kickoff Meeting
Belgrade 22-23 September 2016

Energy Planning Today in Greece

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facets

further action on climate, environment, energy, economy, technology & sustainability

FACE³TS S.A. Scope and Staff

Provide Consulting services to & Conduct applied research & development for:

- public agencies of the central administration and local authorities in Greece, the European Union and other member states or third countries
- private entities including enterprises and associations

On issues of

- Energy
- environment
- climate

and in particular in their complex **interdependence and interaction** under the influence of technology advances and the demands of sustainability.

By a Staff of

- 7 highly qualified professionals (5 with Ph.D and 2 with M.Sc. Degrees in engineering and applied sciences) all with at least 15 years of experience in the areas of the company's activity
- 7 Collaborating and support staff

Areas of activity and Costumers

Over the last 10 years FACE^{3}TS has provided consulting services on:

- Emissions trading and GHG emissions inventories
- Assessment of weather and climate change risks and impacts
- Environmental impact assessments
- Air and water pollution studies
- Forecasting energy demand and renewable energy production
- Assessment of energy conservation potential and evaluation of measures
- Renewable energy source utilization services
- Sustainability planning at company/municipal/regional level

to over 50 costumers in Greece, Italy, Spain and Germany, including:

- Some of the largest enterprises in Greece [Public Power Corporation, Piraeus Bank, Telecommunications Organization of Greece (OTE), Attica Group (Shipping)]
- Over 40 SMEs in the energy, food, real estate and environment sectors
- Ministries, Prefectures and Municipalities of Greece

Recent projects of relevance

“ Environmental and climate risk assessment of selected activity sector in Greece" (2013-2016)
Awarded by Piraeus Bank S.A.
“Feasibility study for large scale penetration of energy efficiency in the residential sector” (2015)
Awarded by: GREENPEACE Greece
“Collection and processing of final energy consumption data” (2013-2015)
Awarded by and Customer: Center for Renewable Energy Sources and Savings (CRES),
“ Consulting services to meet the requirements of PPC power stations that stem from the Emissions Trading System Directives 2003/87/EC και 2009/29/EC and Regulation 601/2012/EU for the 3rd period 2013-2020” (2013-2016)
Awarded by Public Power Corporation, S.A.
“Technical support provision for investment proposal for RES exploitation under Measures 121&123 and Axes 3&4 of the EC Rural Development Programme (RDP) 2007-2013" (2011-2014)
Awarded by: Ministry of Rural Development and Food
“Consulting services to address environmental and social issues for the development of a 330MW wind park on the island of Skyros” (2012-2013)
Awarded by ENTEKA, S.A.
“ Financial institutions: Preparing the market for adapting to climate change (CLIMABIZ project)” (2010-2012) *selected as one of the best 20 LIFE+ Projects in 2012*
Awarded by European Commission-LIFE+
“Compilation of scenarios for energy conservation, demand and emissions for 2020" (2009)
Awarded by: Greek National Center for Renewable Energy Sources (CRES)/Ministry for Development, Greece

National Projects of relevance in which FACE^{3}TS staff participated

- **Low Carbon South East Europe (LOCSEE project),** Intereg Programme, EC 2013-2014
- **Greek National Energy Planning: 2050 Road Map,** Greek Ministry of Energy and Environment (2012)
- **Greek National Renewables Action Plan (NREAP)** in the scope of Directive 2009/28/EC**,** Greek Ministry of Energy and Environment (2010 and 2012)
- **Staff Working Paper for the 2010 Renewable Energy Development Law**, Greek Ministry of Energy and Environment (2010)
- **Development of the Physical Hazards Response Manual of the Greek Municipalities,** Union of Greek Municipalities (2007-2008)
- **National Programme for the Reduction of Greenhouse Gases Emissions,** Ministry for the Environment, Physical Planning & Public Works, Greece (2006)
- **Compilation of the Greek National Emissions Allowances Allocation Plan for the period 2008-2012,** Minister for the Environment, Physical Planning & Public Works, Greece (2006)
- **Compilation of the Greek National Emissions Allowances Allocation Plan for the period 2005-2007,** Minister for the Environment, Physical Planning & Public Works, Greece (2004)

Modelling capabilities

- ENPEP
- WASP
- RWF
- GAMS
- GTMAX
- Electricity Demand Forecasting
- Wind Energy Forecasting

The **ENPEP-BALANCE** model is a methodological energy system simulation framework in partial equilibrium, identifying energy flows, prices and emissions for the energy system of a country by trying to locate the point where the supply and demand curves intersect for all forms of energy supply and all energy uses included in the energy system. The solution is non-linear and on the basis of the market mechanism.

The **WASP** model is an International Atomic Energy Agency Model, based on linear programming, aiming to the medium-termed analysis of alternative development ways of an power generation system for covering the demand and achieving the national energy and environmental targets

The **RWF** model is a fully 3-D baroclinic regional forecasting model utilizing input from global scale models with a number of boundary layer schemes, providing reliable forecasts for up to 6 days ahead for all meteorological parameters with very large spatial resolution (below 500m) through the utilisation of nested grids.

Greece / 2014 Energy Balance (appreviated)

Greece	Total all products	Solid fuels	Oil (total)	Gas	Total Renewables	Wastes (non ren.)	Electricity
Primary production	8,805	6,384	65	5	2,329	21	
Imports	33,182	199	29,576	2,467	127		814
Stock changes	46	109	-77	12	2		
Exports	15,778	6	15,705		12		55
Bunkers	1,865		1,865				
Gross inland consumption	**24,430**	**6,687**	**12,034**	**2,484**	**2,446**	**21**	**758**
Transformation input	**36,851**	**6,483**	**28,990**	**1,281**	**76**	**21**	
Conventional Thermal Power Stations	8,980	6,483	1,125	1,281	71	21	
Refineries	27,865		27,865				
Transformation output	**31,207**		**27,857**		**1**		**3,301**
Conventional Thermal Power Stations	3,350						3,301
Refineries	27,857		27,857				
Exchanges and transfers, returns	**-24**		**-24**		**-1,028**		**1,028**
Consumption of the energy branch	**2,125**		**1,635**	**14**	**1**		**474**
Distribution losses	**357**						**357**
Available for Final Consumption	**16,281**	**204**	**9,241**	**1,189**	**1,341**		**4,256**
Final non-energy consumption	**705**		**357**	**348**			
Final energy consumption	**15,574**	**232**	**8,864**	**835**	**1,338**		**4,256**
Industry	3,088	227	1,128	464	163		1,107
Transport	6,467		6,289	14	134		29
Other Sectors	6,019	6	1,447	357	1,040		3,120
Statistical differences	**2**	**-28**	**20**	**6**	**3**		

RES in Gross Final Energy Consumption 15.1% (2446/16281)

Energy Targets

Greece in the scope of the 20-20-20 targets and obligations has specified in Art 1 of Law 3851/2010 the following targets (in addition to the fixed ones i.e. 10% by RES of the transport energy and 6% on transport fuels, etc):

- **20%** (2% above the 18% specified in Directive 2009/28/EC) of gross final energy consumption to be generated by RES by 2020
- **40%** of gross electricity consumption to be generated by RES by 2020

These targets were reiterated in Law 4414/16Aug2016 (Art 1)

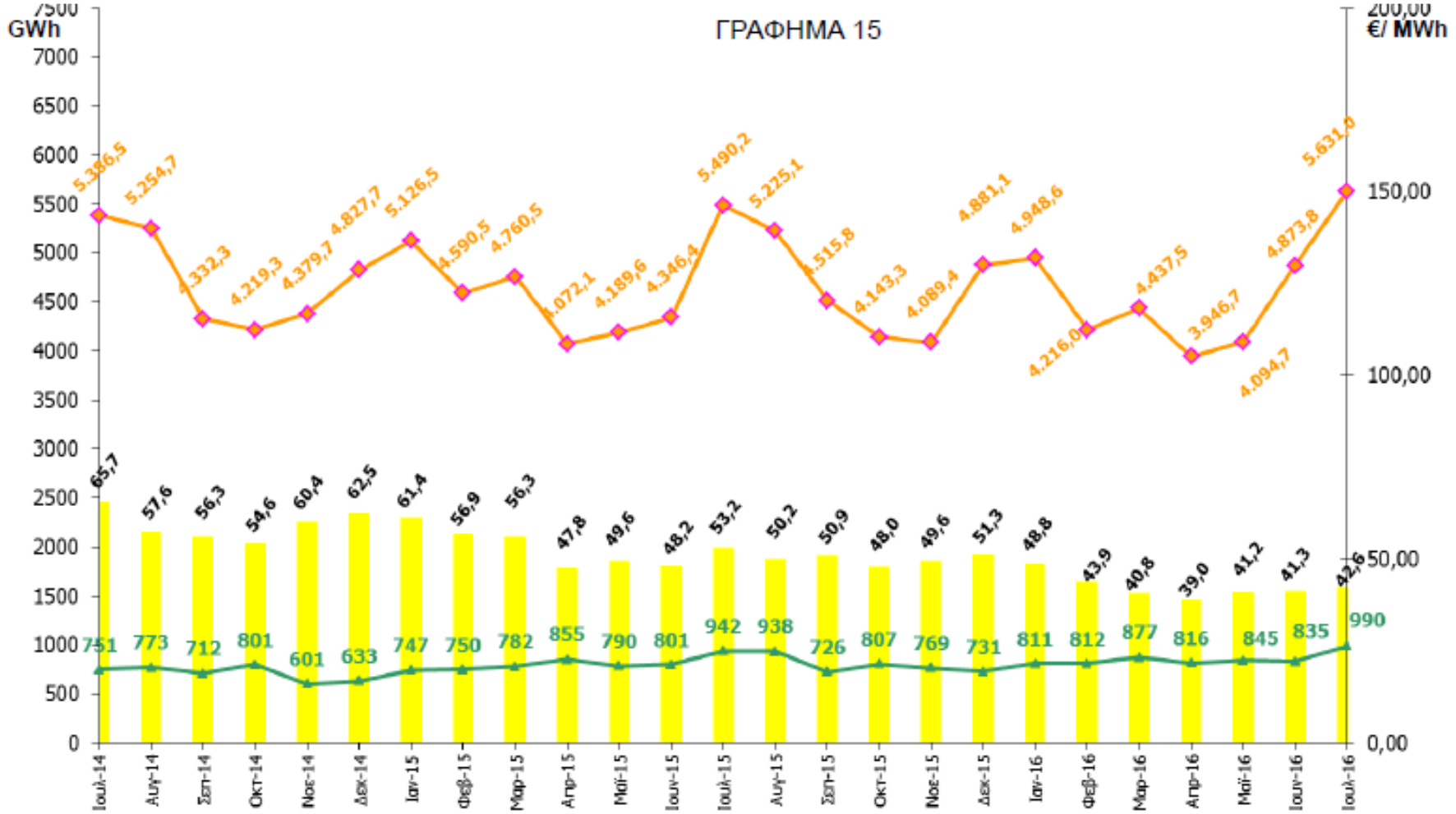
Also GHG emissions from non-ETS sectors to decrease by **4%** by 2020 compared to 2005 as specified by the ESD (to increase to 16% tentatively in 2030)

Electricity Production – Mainland grid

Total

2014 20.2%
(11953/59151)

RES



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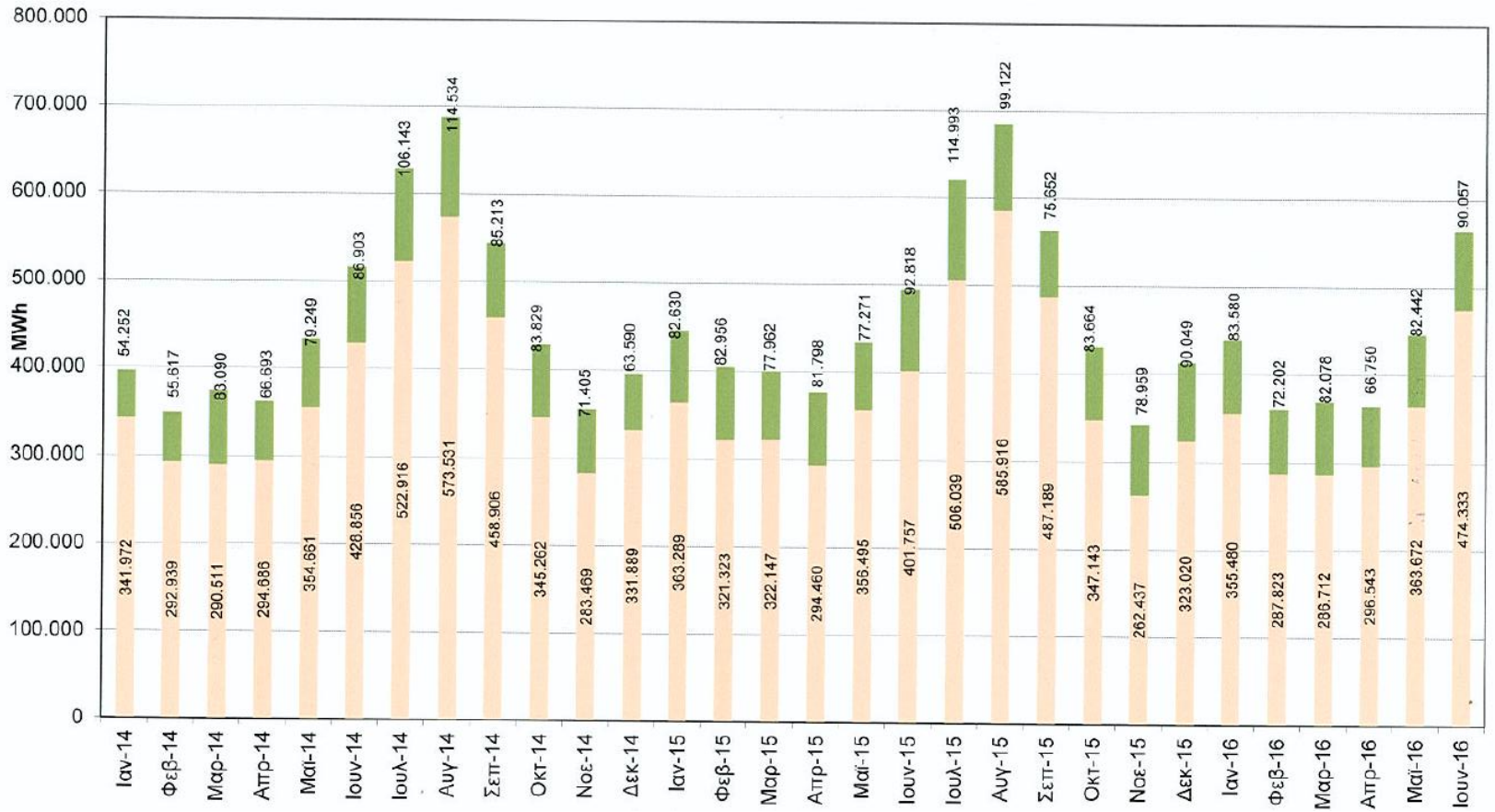
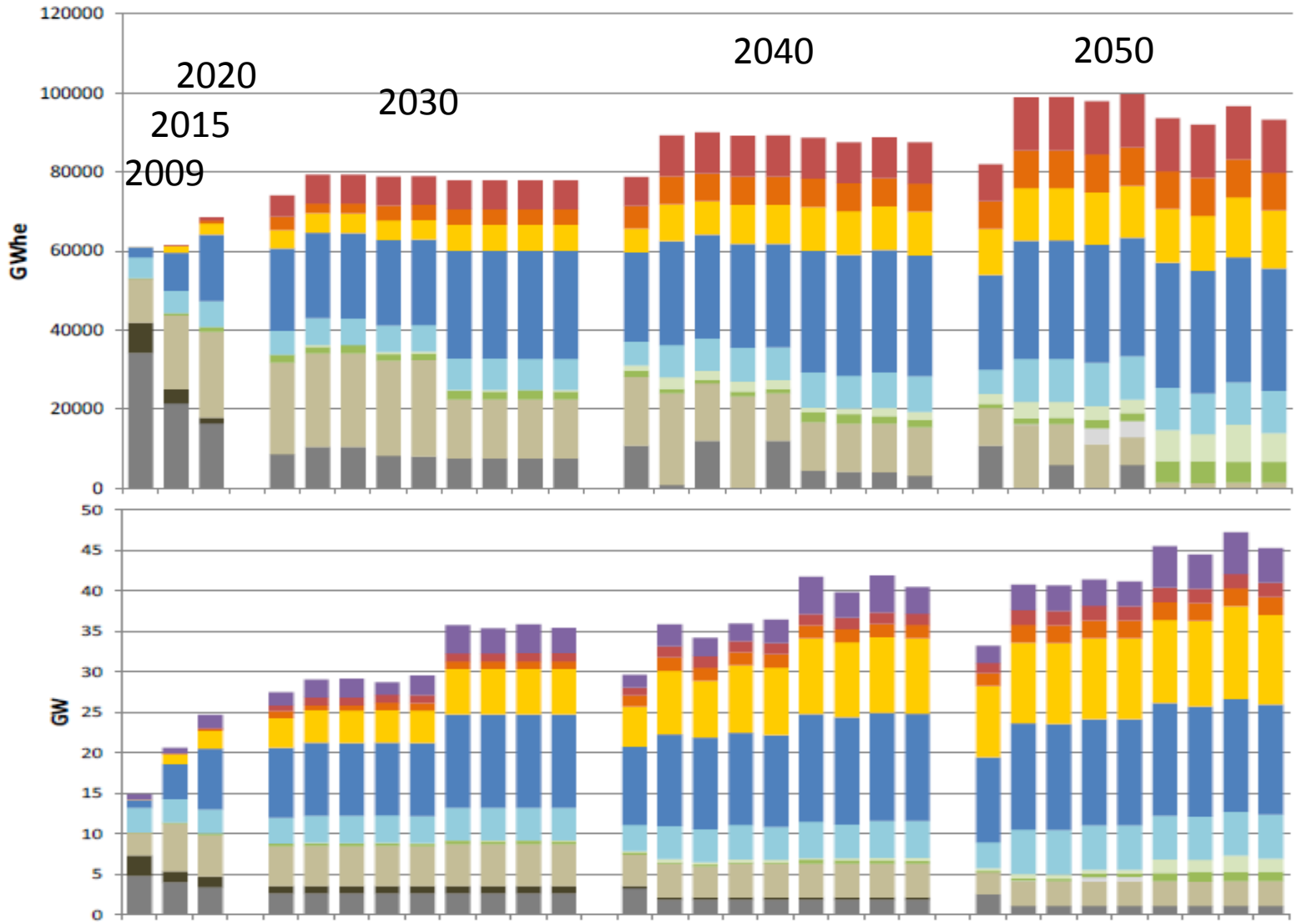
Electricity Production – Islands

RES
459MW

Thermal
1760MW



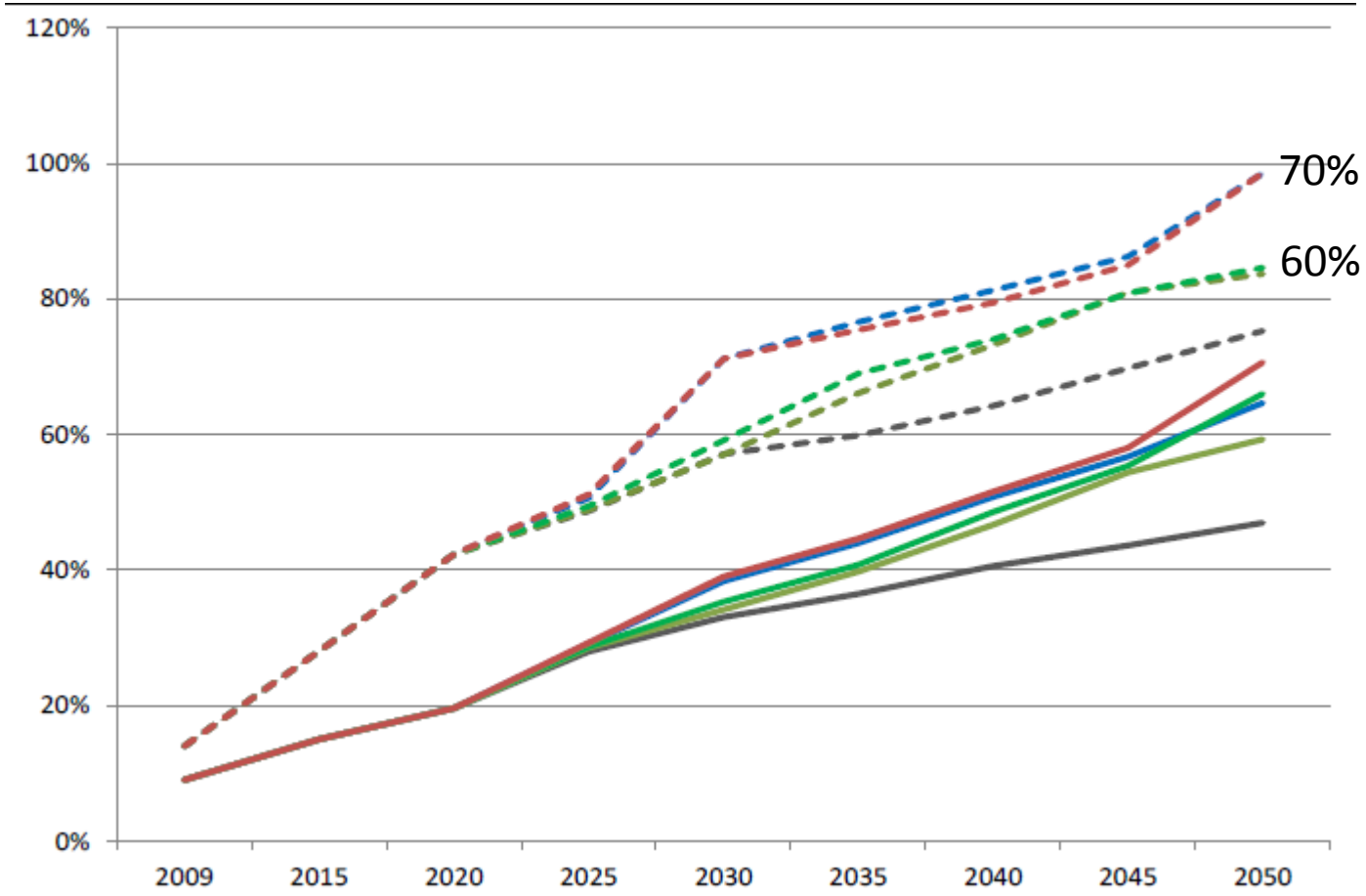
Greek Road Map 2050 / electricity production & installed capacity



9 scenarios (a BAU, 4 for least cost, , for 60% and 70% emission reduction, and with and without CCS and 4 for max RES penetration)

(pumped storage0
Geothermal
CSP
PV
Hydro
Biogas
Biomass
NG Fuel cells
NG
Oil
Solids

Greek Road Map to 2050 / RES penetration



% RES in electricity consumption (dotted) and in final energy consumption (solid) for 5 scenarios (a BAU, 2 for least cost, 2 for max RES penetration and all for 60% and 70% emission reductions)

CRES scenarios Dec 2015

Electricity Production [GWh]			Scenario 0		Scenario 3		Scenario 3p	
		2013	2020	2030	2020	2030	2020	2030
	Total	**54417**	**53372**	**58567**	**53434**	**59152**	**53377**	**59301**
	Lignite	23228	20944	12876	20944	12006	20944	12140
	Oil	4908	3504	2568	3536	2574	3535	2574
	Natural gas	12150	9259	8353	7080	7713	4373	7516
	NG- Fuel Cells	0	0	0	0	315	0	427
	Biomass-Biogas	19	249	243	110	430	564	903
	Biogas - Fuel Cells	0	0	907	0	852	0	484
	Hydro	6341	5596	5596	5593	6495	5956	6088
	Wind	4211	8860	20741	8892	18750	10976	19250
	PV	3559	4616	5892	6937	8625	6687	8528
	Geothermal	0	342	1390	342	1390	342	1390

Gross Final Consumption (ktoe)			Scenario 0		Scenario 3		Scenario 3p	
		2013	2020	2030	2020	2030	2020	2030
	Total	**15867**	**17084**	**18151**	**16859**	**17812**	**16851**	**17840**
fuel	Solid fuel	245	246	248	246	250	246	250
	Oil	8949	9000	8442	8695	8192	8557	8080
	NG	794	1304	1786	1263	1595	1237	1595
	Electricity	4368	4555	5030	4569	5099	4566	5112
	Heat	36	38	95	38	95	38	95
	RES	1475	1941	2550	2048	2580	2206	2708

CRES Scenarios Dec 2015

Targets		Scenario 0		Scenario 3		Scenario 3p	
	2013	2020	2030	2020	2030	2020	2030
Emissions (Mt CO_2eq)	96	87	69	85	67	84	67
Non ETS em (Mt CO_2eq)	43	42	40	41	38	40	38
Non ETS reduction (compared to 2005)	32%	35%	38%	36%	40%	37%	41%
% RES in Gross Final Consumption	16%	20%	30%	21%	31%	24%	32%
% RES in electricity generation	24%	35%	57%	39%	60%	44%	60%
% RES Thermal Final Consumption	27%	29%	33%	31%	34%	31%	34%
% RES in Gross electricity consumption	23%	32%	52%	35%	54%	40%	55%
% Biofuel in transport	3%	5%	8%	7%	11%	10%	13%

EU Reference Scenario 2016 – Greece / Generation

	2005	2015			2030					2050
Population (in million)	**11**	**11**	**11**	**11**	**11**	**10**	**10**	**10**	**10**	**9**	**9**
GDP (in 000 M€13)	**190**	**231**	**232**	**200**	**207**	**213**	**225**	**246**	**268**	**282**	**296**
Gross Inland Consumption (ktoe)	**28292**	**31410**	**28725**	**26055**	**25165**	**23054**	**20886**	**21083**	**20674**	**19210**	**18852**
Solids	9038	8944	7863	6765	5608	4573	2943	3071	2348	471	39
Oil	16085	18119	14974	12997	12166	10929	9728	9410	9122	8831	8684
Natural gas	1705	2354	3235	2979	3778	3346	3279	3434	3583	3629	3591
Nuclear	0	0	0	0	0	0	0	0	0	0	0
Electricity	-1	325	491	600	481	246	221	176	339	352	324
Renewable energy forms	1466	1668	2163	2714	3212	3961	4714	4993	5282	5928	6214
Energy Branch Consumption	**1634**	**1820**	**1839**	**1906**	**1781**	**1636**	**1454**	**1447**	**1379**	**1245**	**1210**
Non-Energy Uses	**719**	**761**	**1108**	**824**	**848**	**836**	**835**	**878**	**913**	**904**	**911**
Gross Electricity generation by source [1] (GWh_e)	**53425**	**59427**	**57367**	**54082**	**58052**	**57523**	**54970**	**58077**	**57279**	**57025**	**58595**
Nuclear energy	0	0	0	0	0	0	0	0	0	0	0
Solids	34313	35543	30797	26751	22885	19611	11963	12644	9364	1821	0
Oil (including refinery gas)	8885	9207	6089	4847	5122	2384	131	123	126	57	59
Gas (including derived gases)	5920	8171	9830	8817	13840	11444	11286	11389	11642	12620	12576
Biomass-waste	163	222	319	195	382	660	812	1091	1061	1781	1784
Hydro (pumping excluded)	3693	5017	7460	5880	5901	5552	5578	5631	5618	5609	5607
Wind	451	1266	2714	3834	5207	10434	15949	16021	17857	21281	22200
Solar	0	1	158	3757	4715	7438	9252	11177	11611	13856	16368
Geothermal and other renewables	0	0	0	0	0	0	0	0	0	0	0
Other fuels (hydrogen, methanol)	0	0	0	0	0	0	0	0	0	0	0

RES 2416/16281=14.9% (2014)

EU Reference Scenario 2016 – Greece / Installed capacity

	2005		2015			2030				2050
Net Generation Capacity (MW.)	**11212**	**13208**	**15889**	**19208**	**19703**	**22088**	**23780**	**24196**	**24086**	**25436**	**26514**
Nuclear energy	0	0	0	0	0	0	0	0	0	0	0
Renewable energy	3298	3598	4715	8146	9363	12651	15233	16105	16768	18962	20371
Hydro (pumping excluded)	3072	3106	3215	3389	3579	3579	3579	3579	3579	3579	3579
Wind	226	491	1298	2152	2637	4306	6038	6038	6567	7600	7884
Solar	0	1	202	2605	3147	4766	5616	6488	6622	7783	8908
Other renewables (tidal etc.)	0	0	0	0	0	0	0	0	0	0	0
Thermal power	7914	9610	11174	11062	10340	9437	8548	8092	7318	6474	6143
of which cogeneration units	195	3051	588	284	309	316	341	390	446	576	535
of which CCS units	0	0	0	0	0	0	0	0	0	0	0
Solids fired	4454	4754	4312	3923	3030	3100	2845	2834	2834	1405	833
Gas fired	1157	2203	4189	5062	5306	5272	4738	4418	3827	4416	4897
Oil fired	2302	2625	2618	2022	1824	834	733	595	409	378	153
Biomass-waste fired	1	28	55	55	180	230	232	245	249	275	260
Hydrogen plants	0	0	0	0	0	0	0	0	0	0	0
Geothermal heat	0	0	0	0	0	0	0	0	0	0	0
Avg. Load factor of net power capacity [2] (%)	50.3	47.7	38.3	29.6	31.4	28.2	25.5	26.5	26.4	25.3	25.1
Efficiency of gross thermal power generation (%)	36.9	37.0	37.5	38.6	41.4	42.7	43.2	43.0	43.7	54.8	58.5
% of gross electricity from CHP	2.1	7.8	4.3	3.0	3.4	2.9	3.1	3.9	4.3	4.5	6.6
% of electricity from CCS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of carbon free (RES, nuclear) gross electricity generation	8.1	10.9	18.6	25.3	27.9	41.9	57.5	58.4	63.1	74.6	78.4

EU Reference Scenario 2016 – Greece / Decarbonization

		2005		2015		2030					2050
TOTAL GHG emissions (Mt of CO2 eq.)	**133.3**	**139.6**	**121.4**	**105.7**	**96.6**	**85.1**	**71.7**	**70.9**	**66.7**	**55.9**	**52.6**
of which ETS sectors (2013 scope) GHG emissions		77.2	64.9	57.3	52.9	44.6	34.4	34.6	30.9	21.0	18.3
of which ESD sectors (2013 scope) GHG emissions		62.4	56.5	48.4	43.7	40.5	37.3	36.3	35.8	34.9	34.3
CO_2 Emissions (energy related)	**98.4**	**106.4**	**92.1**	**79.6**	**72.9**	**62.7**	**50.4**	**50.3**	**45.8**	**35.2**	**32.4**
Power generation/District heating	52.1	55.6	47.9	40.9	37.0	28.9	19.1	19.9	16.4	6.5	4.3
Energy Branch	3.1	3.4	3.6	3.9	3.6	3.3	3.0	3.0	2.9	2.7	2.7
Industry	10.4	8.9	7.2	6.2	6.0	5.3	4.5	3.8	3.4	3.2	2.8
Residential	7.6	9.9	6.7	5.0	4.3	4.1	3.7	3.3	3.0	2.8	2.7
Tertiary	3.4	4.3	2.8	1.8	1.2	1.0	0.9	0.9	0.9	0.9	0.8
Transport	21.8	24.4	24.0	21.7	20.9	20.0	19.2	19.3	19.3	19.2	19.1
CO_2 Emissions (non energy and non land use related)	**8.9**	**9.6**	**6.6**	**6.8**	**6.7**	**6.9**	**7.2**	**6.6**	**6.7**	**6.8**	**6.1**
Non-CO2 GHG emissions	**26.1**	**23.6**	**22.6**	**19.3**	**16.9**	**15.4**	**14.0**	**14.1**	**14.2**	**13.9**	**14.1**
TOTAL GHG emissions (excl. LULUCF) Index (1990=100)	**124.1**	**129.9**	**113.0**	**98.4**	**89.9**	**79.2**	**66.7**	**66.0**	**62.1**	**52.0**	**49.0**
Carbon Intensity indicators											
Electricity and Steam production (t of CO_2/MWh)	0.97	0.93	0.83	0.75	0.63	0.49	0.34	0.33	0.28	0.11	0.07
Final energy demand (t of CO_2/toe)	2.32	2.26	2.12	1.99	1.89	1.86	1.81	1.74	1.69	1.65	1.62
Industry	2.35	2.13	1.96	1.91	1.80	1.68	1.54	1.31	1.15	1.07	0.99
Residential	1.69	1.79	1.45	1.16	1.01	1.00	0.93	0.86	0.80	0.76	0.73
Tertiary	1.41	1.38	1.01	0.76	0.54	0.48	0.44	0.43	0.40	0.38	0.36
Transport	2.99	2.98	2.94	2.90	2.87	2.87	2.85	2.84	2.82	2.80	2.78
RES in Gross Final Energy Consumption [7] (in%)	**7.2**	**7.0**	**9.7**	**14.4**	**18.4**	**23.6**	**29.6**	**31.4**	**33.5**	**37.8**	**40.0**
RES-H&C share	13.6	12.8	17.4	24.8	[illegible]	32.6	36.8	39.7	42.9	45.0	46.5
RES-E share	7.2	8.2	12.3	22.4	25.8	39.9	55.0	56.6	59.2	69.9	74.0
RES-T share (based on ILUC formula)	0.0	0.0	1.9	1.4	[illegible]	11.4	14.2	15.9	17.7	21.0	23.2

RES-E 1028/5087=20.2% (2014)

Current Situation - 1

Energy Planning

- Until 2014 there existed a National Energy Planning Committee
- The Greek Road Map to 2050 was produced in 2012 (but never officially adopted) under its auspices
- The Committee has not met since January 2014 when its membership changed
- In 2014 it was tasked to produce within 3 months a draft energy plan to be put out for consultation for 3 weeks
- No new energy plan has been presented in public.
- The Greek National Center for Renewable Energy Sources (CRES) has been producing a number of scenarios to support the Ministry of Environment and Energy but none have been officially adopted.
- In addition the NREAP and NEEAP have been submitted on time as have the 2nd biennial progress reports in 2015 and 2016 respectively

Current Situation - 2

JMD 19598/1-10-2010 under Law 3851/2010 specifies RES development till 2020

Technology	Target installation (MW)		Installed Capacity (MW)
	2014	2020	30 June 2016
Small hydro (<15MW) Large hydro	300 3400	350 4300	218 3171
PV (rooftop)	1500	2200	2580 (375)
Solar thermal	120	250	0
Wind	4000	7500	2289
Biomass	200	350	46

Current Situation - 3

Law 4414 of 16 August 2016 on the Support of RES/CHP

- Latest of a succession of laws from 2006 which specified a FIT regime
- Framework law with a large number of JMDs to be issued for details
- Introduces a FIP regime for large projects
- Introduces auctions for RES capacity starting with PV in 2016
- Provides a transition regime for projects in the pipeline
- Requires that all large installations take on obligations of notification and/or participation in the scope of the day- ahead and intra-day markets
- Provides for contracts for remuneration of 20Yrs duration

Draft Law on the establishment of the Target Model

- Out for Public Consultation to be tabled in Parliament by the end of September
- Introduces 4 markets (Forward, Day-ahead, Intraday and Balancing)
- Specifies the Market Operators and their remit (2 existing, 1 or more new)
- Provides for a new set of Codes for the operation of the markers
- Authorizes the Regulatory Agency for Electricity to supervise the codification and operations and tasks it to provide inputs for new legislation as required

Thank you for your attention

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