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Renewable Energy Technology integration for the island of Cyprus: A cost-optimization approach

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Background

- Small island in Eastern Mediterranean
- Service-oriented economy

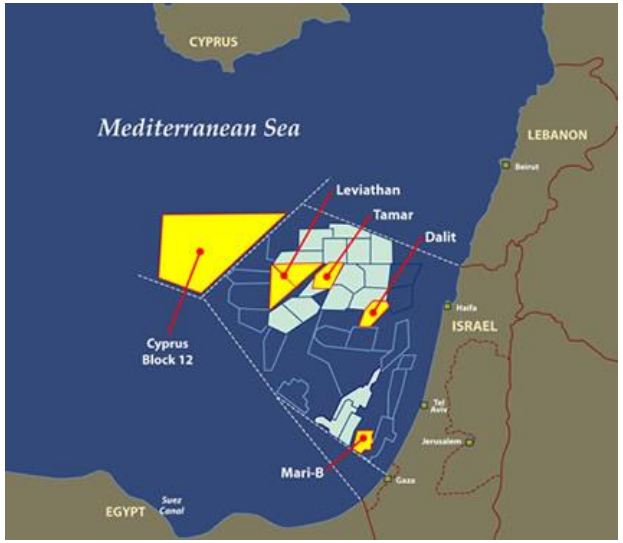
- No grid interconnections
- Electricity: >90% fossil fuel-fired
- Fossil fuels imported

- Financial crisis in 2013 fuelled by banks, but also…
- Vasilikos PP explosion
  - Rolling blackouts
  - Higher generation cost (~33%)

Recent developments in Cyprus Energy Sector

- Offshore natural gas finds
- Possibility of Interim Gas Solution (2016-2022)
- Potential grid interconnection (Israel-Cyprus-Greece)
- Potential LNG terminal for exports (currently unlikely)

- 2020 and 2030 targets for RE
- CO_2 emissions
- Industrial gas emission restrictions



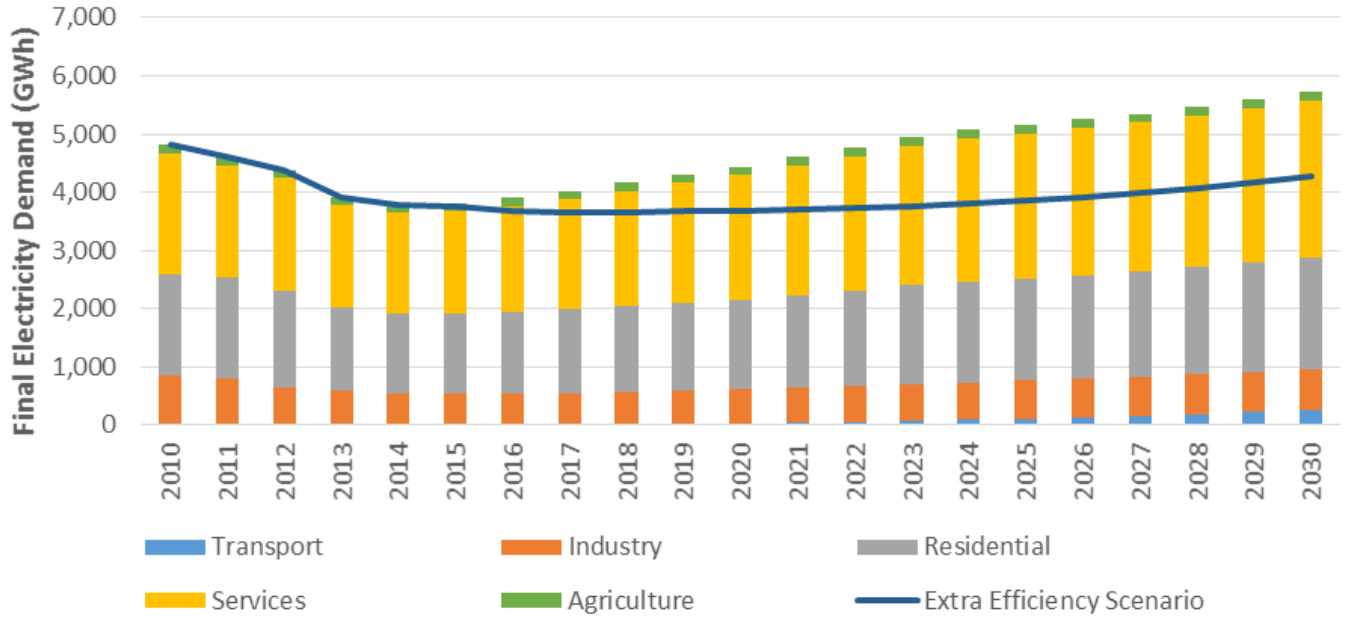
Project Aim

Insights on the future role of renewable energy technologies in the electricity mix, ensuring a cost-optimal power supply mix and taking into account policy targets.

- **policy driver** - EU renewable energy target for Cyprus in 2020, and the country's own aspirational targets for 2030.
- **economic driver** - reduce the current high power generation cost.
- **geopolitical driver** – improve energy security.
- **technical driver** - minimization of any technical challenges in terms of high dependence of the power system on rapidly increasing shares of variable renewable energy sources – *separate JRC study*.

Cyprus Electricity Model

- Developed in MESSAGE
  - Bottom-up cost-optimization tool; demand-driven multi-year energy system model
- Demands as provided by Cyprus University of Technology
  - Energy Efficiency Scenario
  - Extra Efficiency Scenario



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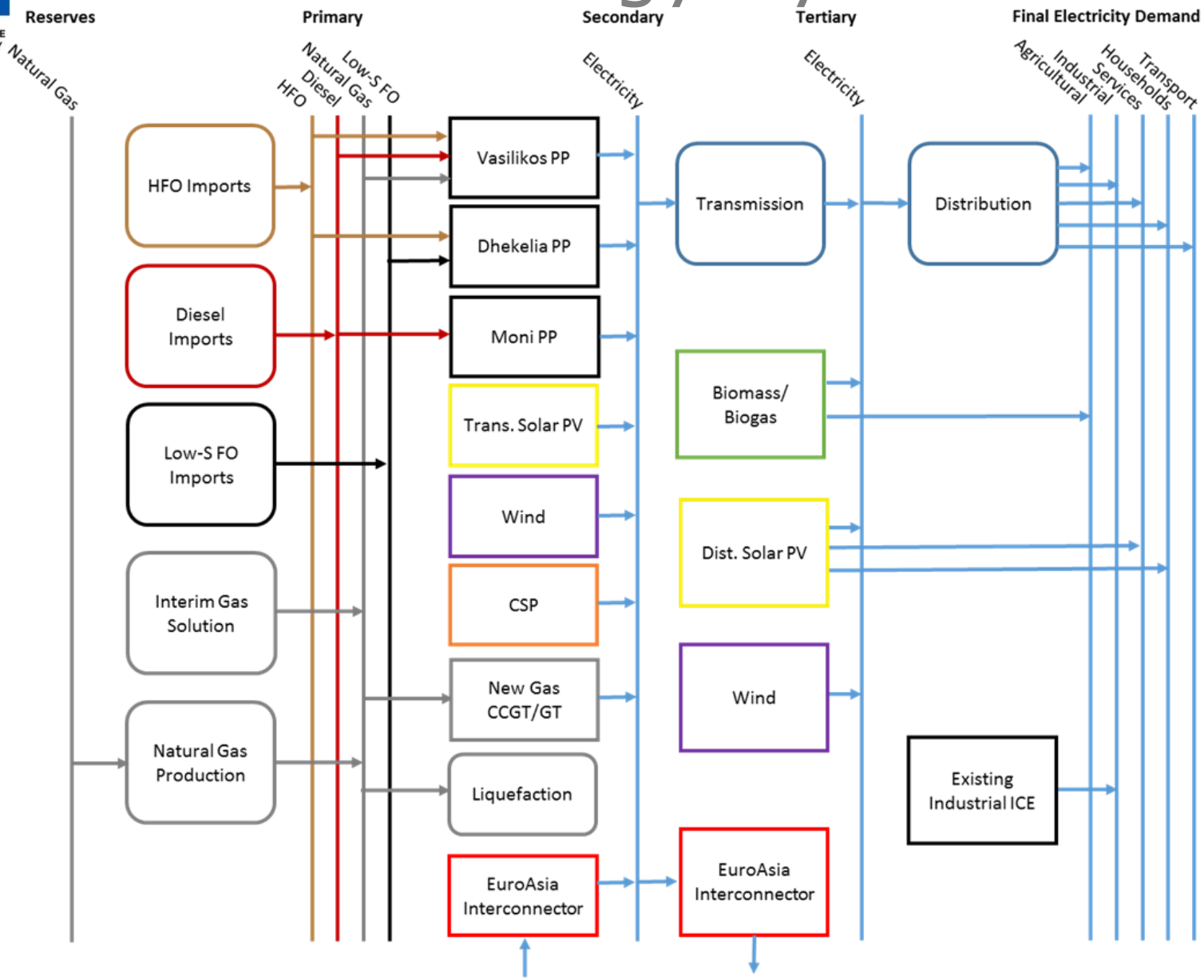
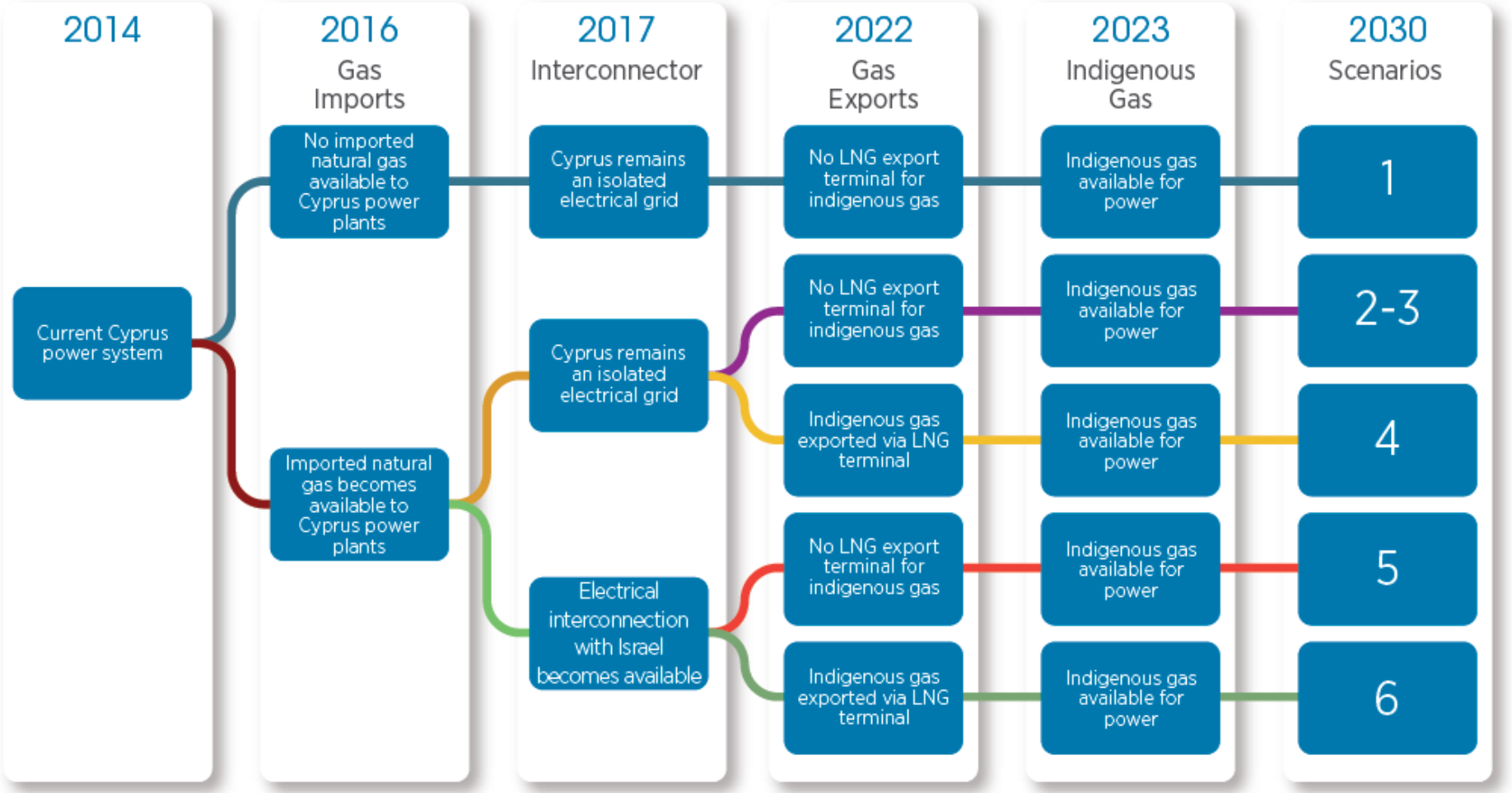
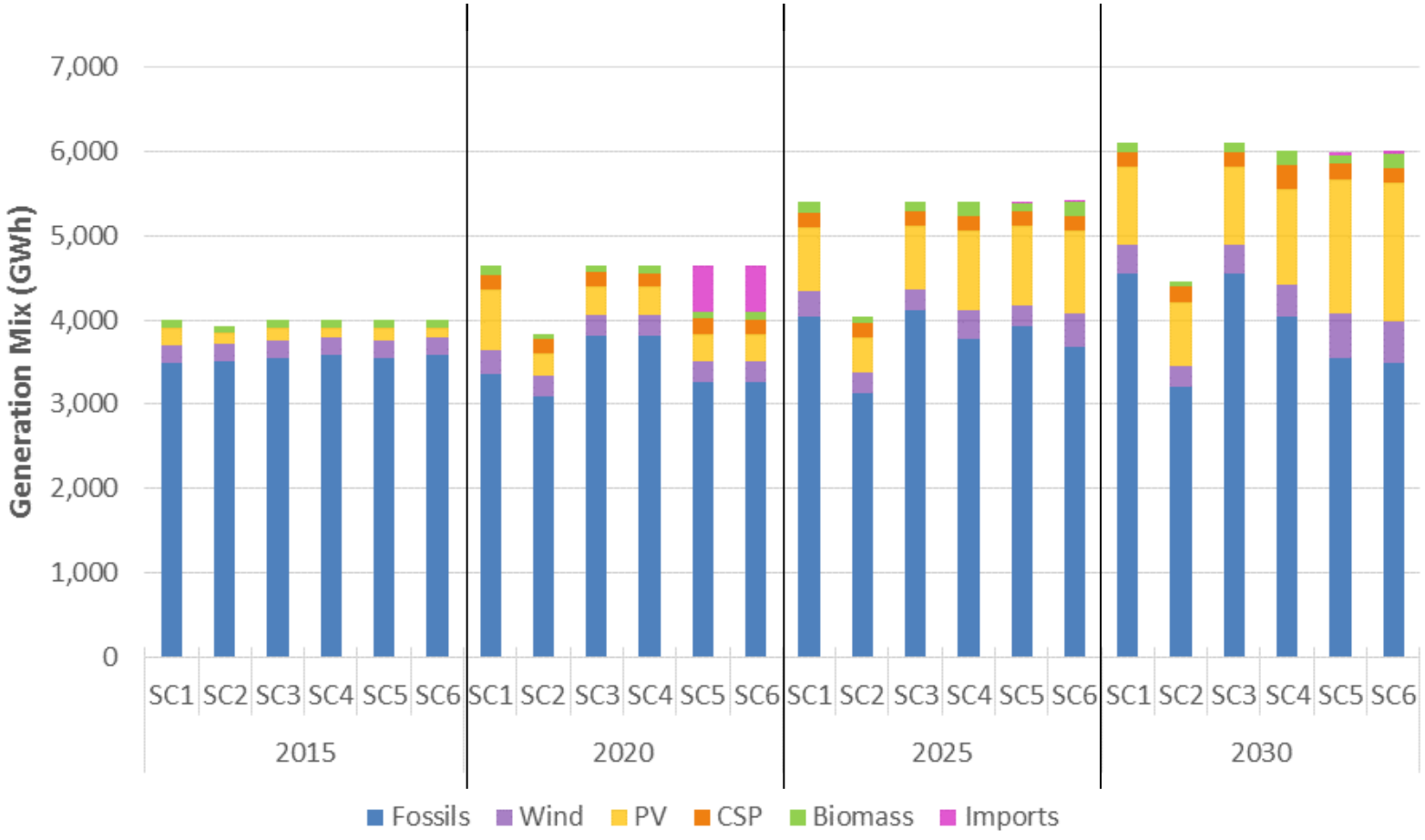
Reference Energy System



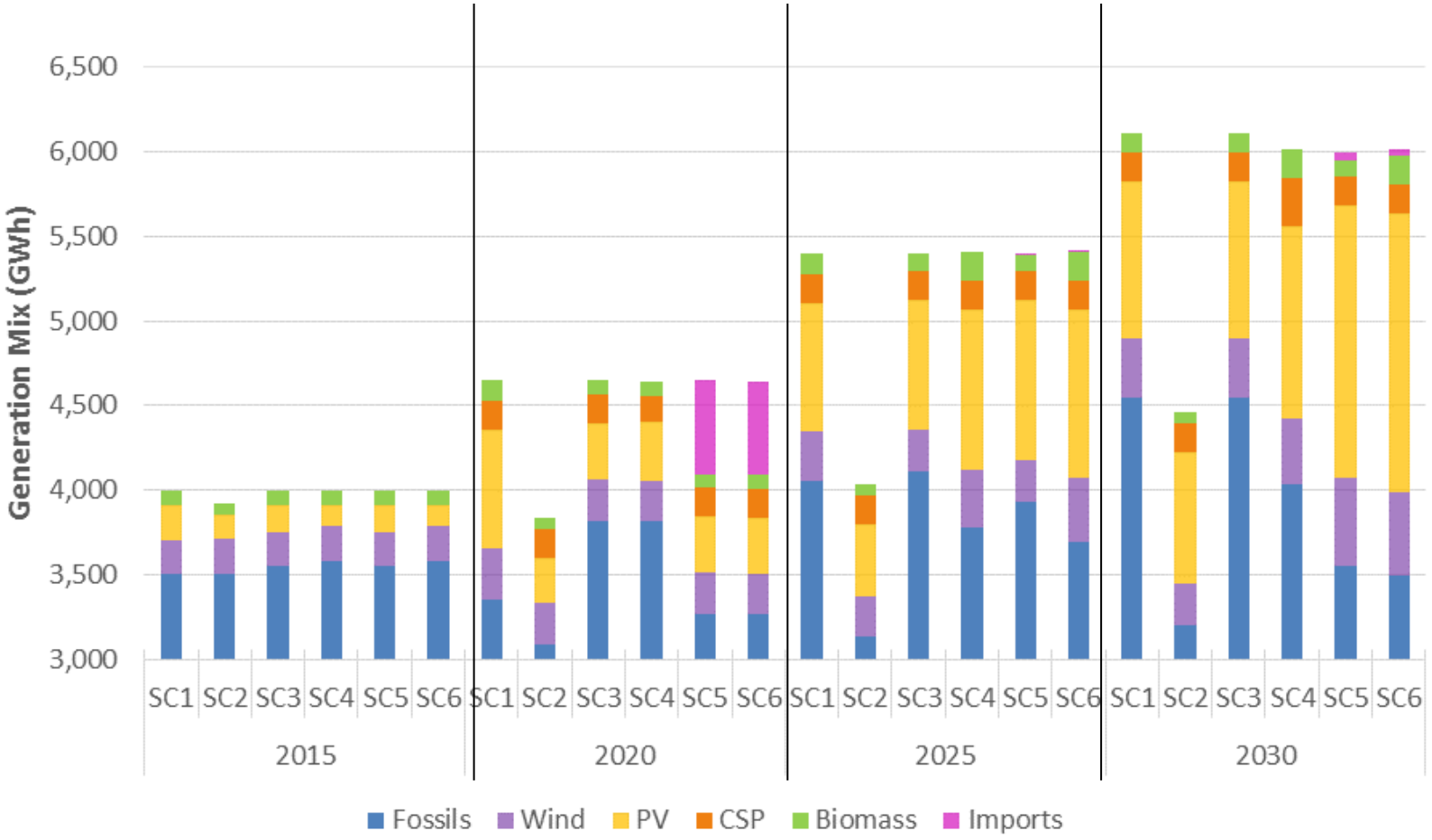
Scenario Definitions



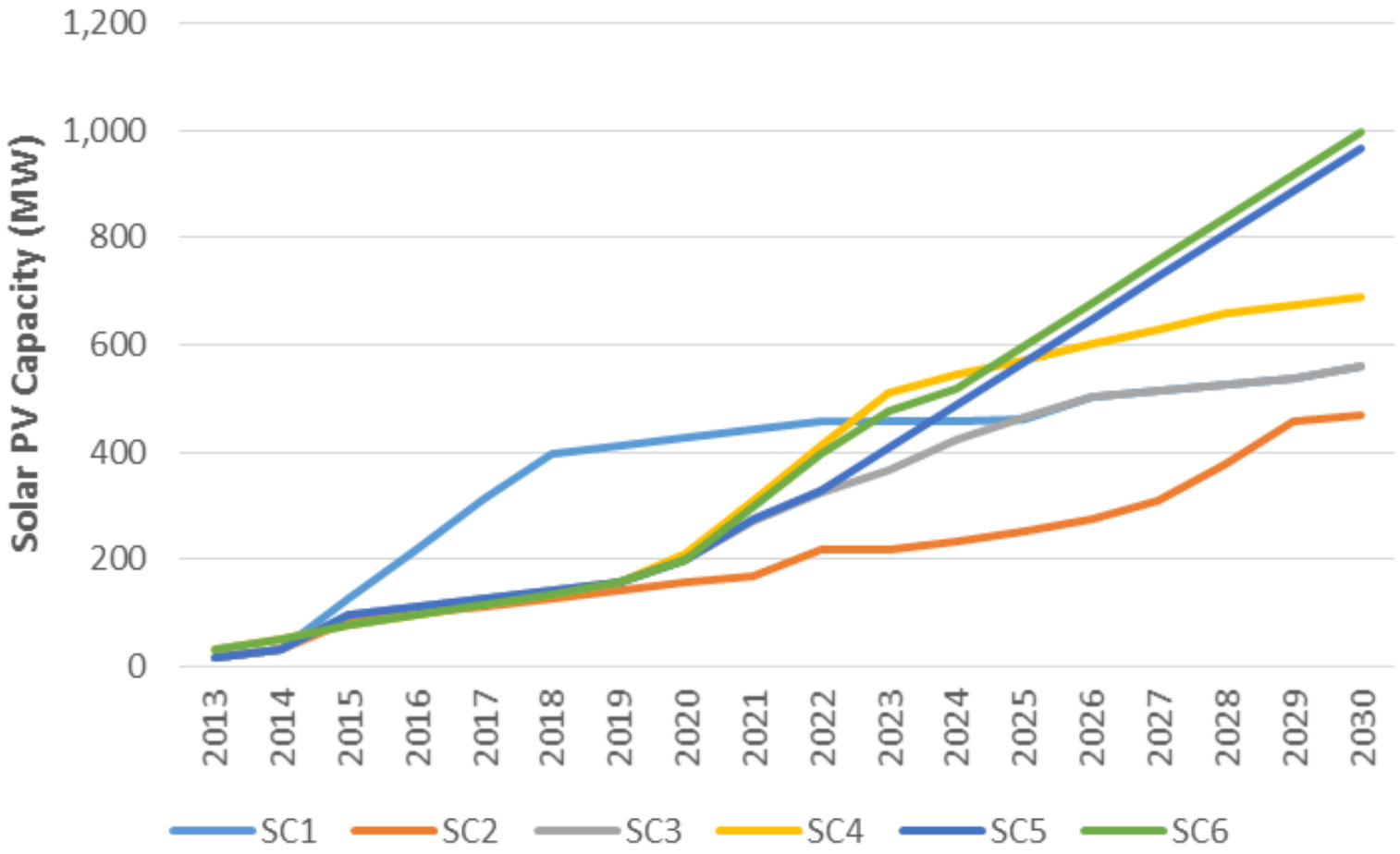
Scenario Comparison Generation



Scenario Comparison Generation



Scenario Comparison Capacity of Solar PV



Scenario Overview

	SC1	SC2	SC3	SC4	SC5	SC6
Renewable energy share in 2020	27.9%	19.5%	17.8%	17.9%	17.8%	17.9%
Renewable energy share in 2030	25.6%	28.3%	25.6%	26.4%	40.1%	33.2%
- Solar PV	15.2%	17.4%	15.2%	15.2%	26.8%	22.0%
- Wind	5.7%	5.5%	5.7%	5.1%	8.7%	6.6%
Cumulative generation investments 2013-2030 (billion EUR)*	1.10	0.70	1.06	1.46	1.45	1.55
Average generation cost in 2013-2030 (EUR/MWh)	101.0	91.6	90.4	91.5	88.9	89.1

* *Cost of some investments such as grid investments, electrical interconnector cost, and energy efficiency measures are not included.*

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Conclusions

- Trans. Solar PV is the most cost-effective RET.
- Some RETs are already cost-competitive to current thermal generation options.
- Scenarios with interconnector lead to high share of RE – clear benefits but also inherent implications.
- Decisions are called for – interim gas solution, RE investments, LNG terminal and interconnector.

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Future Work

- Key areas:
  - Dynamic grid stability analysis – JRC
    - Model to be adjusted accordingly following provided recommendations
  - Storage merits further analysis, based on the quantification of necessary ancillary services and future market design.
  - More accurate representation of unit-specific characteristics.
  - Updated assumptions – fuel prices, planned installations

- Further enhancements:
  - Entire energy sector.
  - Demand side measures – investment into improving efficiency vs power infrastructure.

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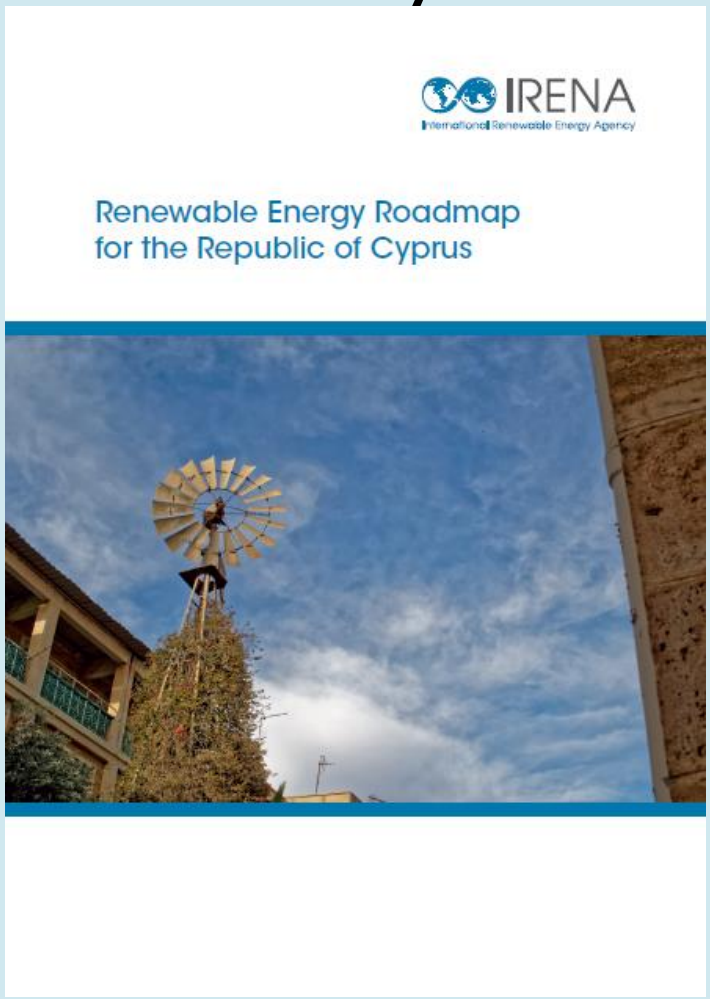
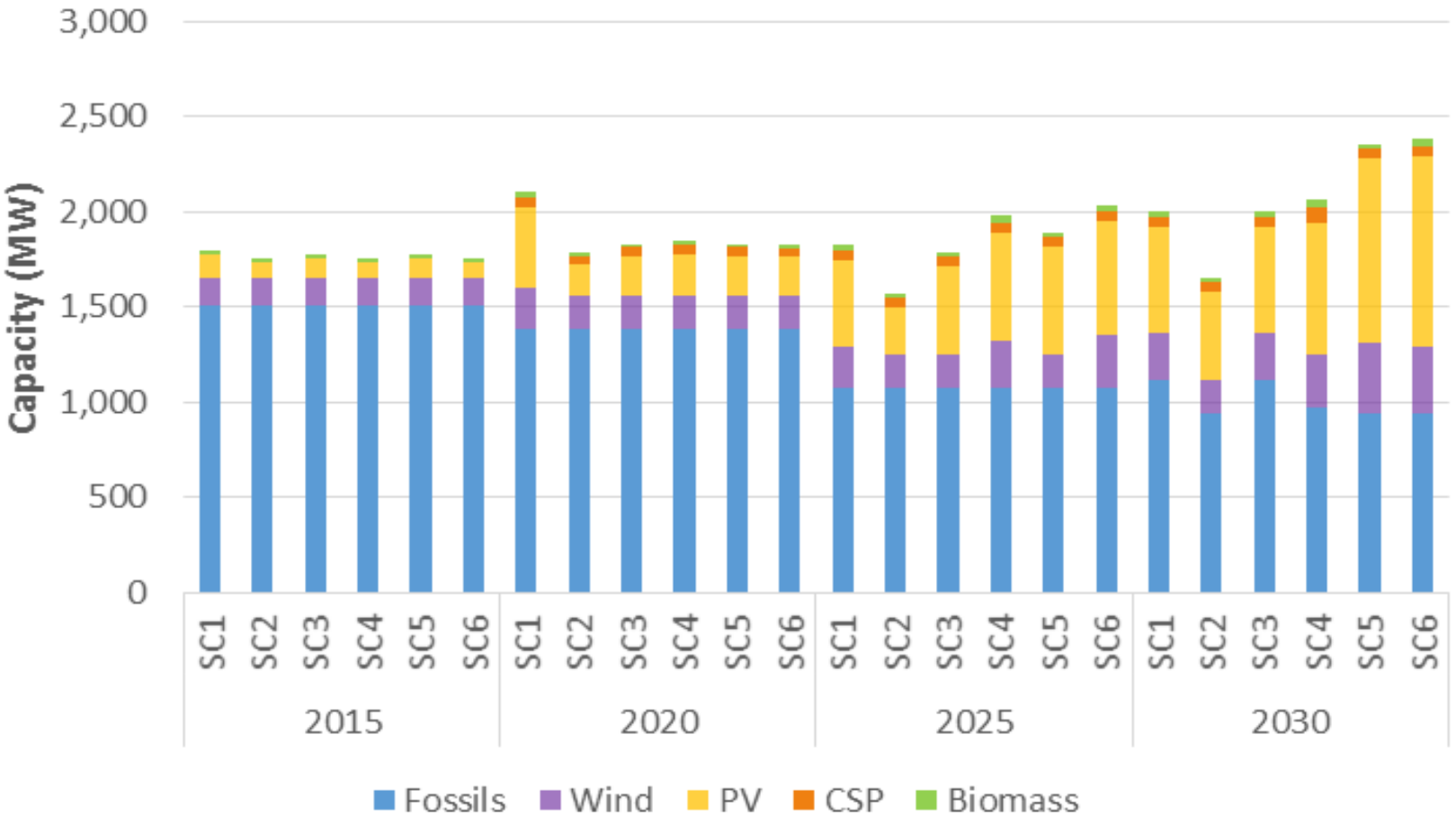
Thank you!



Scenario Comparison - Capacity



RE cost-competitiveness

	SC1	SC2	SC3	SC4	SC5	SC6	RE target	
2013	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.0%	Compulsory
2014	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.3%	
2015	12.4%	10.6%	11.2%	10.3%	11.2%	10.3%	8.4%	
2016	16.5%	11.5%	11.5%	10.9%	11.5%	10.9%	9.4%	
2017	21.6%	12.2%	11.8%	11.4%	11.8%	11.4%	10.8%	
2018	28.0%	18.4%	16.8%	16.6%	16.8%	16.6%	12.4%	
2019	27.9%	18.9%	16.8%	16.8%	16.8%	16.8%	14.1%	
2020	27.9%	19.5%	17.8%	17.9%	17.8%	17.9%	16.0%	
2021	27.5%	20.1%	20.1%	*20.1%*	20.1%	20.1%	20.1%	Aspirational
2022	27.0%	21.8%	21.2%	*21.2%*	21.2%	21.2%	21.2%	
2023	26.0%	21.8%	21.8%	22.7%	22.9%	22.7%	21.8%	
2024	25.4%	22.3%	22.9%	23.2%	24.8%	23.3%	22.3%	
2025	25.0%	22.7%	23.8%	23.7%	26.9%	24.9%	22.7%	
2026	25.9%	23.3%	24.6%	24.3%	28.9%	26.4%	23.3%	
2027	25.7%	24.2%	24.5%	25.2%	30.7%	27.9%	24.2%	
2028	25.5%	26.1%	24.8%	25.9%	32.4%	29.3%	24.8%	
2029	25.3%	28.6%	25.1%	26.1%	36.4%	30.6%	25.1%	
2030	25.6%	28.3%	25.6%	26.4%	40.1%	33.2%	25.3%	

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Challenges

- Intermittency of variable RE
  - Storage (centralized or distributed, electric vehicles)
  - Demand-side management
  - Smart grids
- Lack of grid interconnection
- Flexibility of thermal units
- Ancillary services
  - Operational reserves
  - Frequency control
  - Voltage control (currently transmission-connected wind parks contribute to this).