

# The role of natural gas towards sustainable energy

## systems

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sustainable energy systems

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## EU energy strategy 2020, 2030, 2050

## **Future energy systems**



### Climate change



### Third industrial revolution

### Future energy economics

# **EU energy objectives**



- greenhouse gas reduction
- sustainable production and consumption
- competition in electricity and natural gas markets
- security of supply



### EU medium and long term targets





## EU reduction in greenhouse gas emissions



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## **Current energy system**





\* Poullikkas A., 2009, Introduction to Power Generation Technologies, ISBN: 978-1-60876-472-3

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### Future energy systems (optimistic scenario)



### EU energy system in 2020-30\*



### Future energy systems (optimistic scenario)



### EU energy system in 2040-50\*



\* Poullikkas A., 2009, Introduction to Power Generation Technologies, ISBN: 978-1-60876-472-3

### **Future power systems**





## **End goal – the smart future**





#### The Super Smart Grid after 2050\* (may allow for 100% RES)





\* Poullikkas A., 2013, Sustainable Energy Development for Cyprus, ISBN: 978-9963-7355-3-2

### Long term EU energy strategy (2050)

- A vision of carbon free EU
- Main ingredients of future sustainable energy systems:
  - Large scale integration of renewable energy sources
  - Distributed generation
  - Carbon capture and storage
  - Smartgrids
  - Electric vehicles
  - Storage devices
  - Hydrogen

#### Need to develop advanced simulation tools, new sustainable technologies and infrastructure !!





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## Cyprus current electricity and NG system Statistics

### **Existing power generation system**

- Steam turbine units (HFO)
  - Dhekelia power station 6x60MWe
  - Vasilikos power station 3x130MWe
- Combined cycles (Diesel)
  - Vasilikos power station 2x220MWe
- Gas turbine units (Diesel)
  - Moni power station 4x37,5MWe
  - Vasilikos power station 1x38MWe
- Renewables
  - PVs 115MWe
  - Wind 157MWe
  - Biomass 13MWe







### **Distribution of RES-E**





# **RES-E targets**Current RES-E penetration: ~9%





- PVs 115MWe
- Wind 157MWe
- Biomass 13MWe
- RES-E target for 2020: 16%



- PVs 360MWe
- Wind 175MWe
- Biomass 15MWe

• RES-E target for 2030: not yet

### **Existing natural gas system**



- Under development !
- For power generation as a start...





# The role of natural gas markets

### **Towards sustainable energy systems**

## **Pathways to low emissions**





### Daily load curve (the 'camel curve')\*



 Poullikkas A., 2016, "From the 'camel curve' to the 'duck curve' on electric systems with increasing solar power", *Accountancy* 9<sup>th</sup> Mediterranean Oil & Gas Forum 2018

9<sup>th</sup> Mediterranean Oil & Gas Forum 2 Nicosia, 27-28 March 2018 **ρυθμιστική αρχή** ενέργειας κύπρου cyprus energy regulatory authority

# Effect of PV generation on load curve (the 'duck curve')\*





\* Poullikkas A., 2016, "From the 'camel curve' to the 'duck curve' on electric systems with increasing solar power",

**Accountancy** 9<sup>th</sup> Mediterranean Oil & Gas Forum 2018 Nicosia, 27-28 March 2018

### Gas is a pillar of renewable energy (power production in UK\*)



\* H.V. Rogers, 2011, The Impact of Import Dependence and Wind Generation on UK Gas Demand and Security of Supply to 2025, The Oxford Institute For Energy Studies

9<sup>th</sup> Mediterranean Oil & Gas Forum 2018 Nicosia, 27-28 March 2018 **ρυθμιστική αρχή** ενέργειας κύπρου cyprus energy regulatory authority

## EU gas market target model



#### Vision for an internal gas market

Step 1: Enabling functioning wholesale markets	Step 2: Connecting functioning wholesale markets	Step 3: Ensuring secure supply and economic investment
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#### Realising economic investments in infrastructure

### EU gas market target model



• The new uses for gas have different roles across the gas supply chain







• energy storage technology linking the electricity and gas infrastructure



electricity TSOs

### **Virtual pipelines**



- LNG stations are supplied through trucks
- CNG stations are supplied either from the network or with LNG (L- CNG)



Virtual pipeline: the supply chain transporting natural gas to final consumers in the form of CNG or LNG, using road and sea means of transportation, such as trucks, vessels and rail<sup>29</sup>

### LNG bunkering



 Supply chain is the same for applications in deep-sea trading and inland waterways



LNG bunkering options: Ship-to-Ship (STS), Truck-to-Ship (TTS), Terminal-to-Ship (TPS)



## Summary



- NG is clean
- NG is flexible
- NG is scalable





• NG technology is improving

### NG will play an important role for the development of the future sustainable energy systems