LEAST COST ENERGY SUPPLY

Model For A Multiple Scenario Analysis Of Northern Africa

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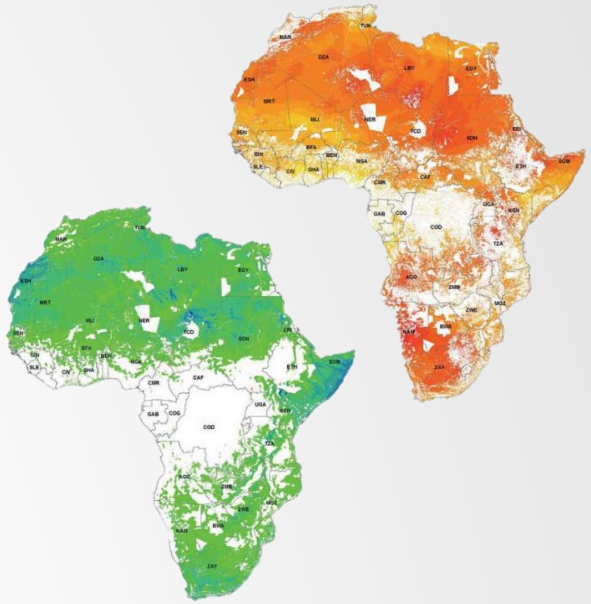
CONTEXT OF THE PROJECT

Background

- High level of natural ressources
- High levels of Renewable resources
- A long-term vision is needed to make optimal use of available domestic resources
- Tools have been developed to support African member countries
- IRENA to accelerate Africa's development



CONTEXT OF THE PROJECT

The Focus

- **Least-cost energy system modelling**
  - Appropriate tool to *explore investment decisions*
  - Reach optimal energy mix & long term transition pathways with high RE
- Framework Northern Africa Energy Model
  - Assess power sector investment needs
  - Fuel economic development
  - Public domain data
- What potential to offset the use of Natural gas with RE – to what benefit for the region?

MESSAGE MODELLING FRAMEWORK

Key Characteristics

Model for Energy Supply System Alternatives and their General Environmental impacts

Medium- to longterm timeframe
Energy system (as opposed to power system)
Optimisation (as opposed to simulation or accounting frameworks)
Linear and Mixed Integer
Dynamic (as opposed to static, i.e., snap shots of time)
Bottom Up (as opposed to top-down, e.g., CGE, econometric or input-output models).

Optimisation objective function

The discounted sum of

Investment cost (minus salvage costs)
Fixed & Variable operation and maintenance costs
Fuel costs
Any additional penalty costs defined for the limits, bounds and constraints on relations

MESSAGE MODELLING FRAMEWORK

Characteristics

Bottom up model ≡ technology intensive

Each technology can be characterised by

- (multiple) inputs and outputs
- Seasonal variation in capacity
- Efficiency varying with time
- Costs varying with time
- Limits on production
- Capacity build-up constraints
- Market penetration constraints
- Emission control

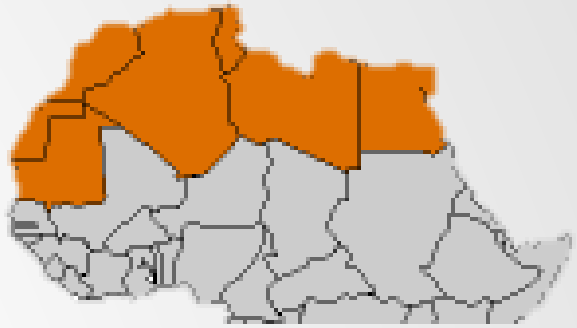
Demands & load regions

Defined exogenously

THE MODEL

General Characteristics

Model of North African states



Timeframe

2010 to 2050; reporting to 2030

Technology Data

Capacity data & Techno economic parameters
IRENA SPLAT modelling databases

Demand

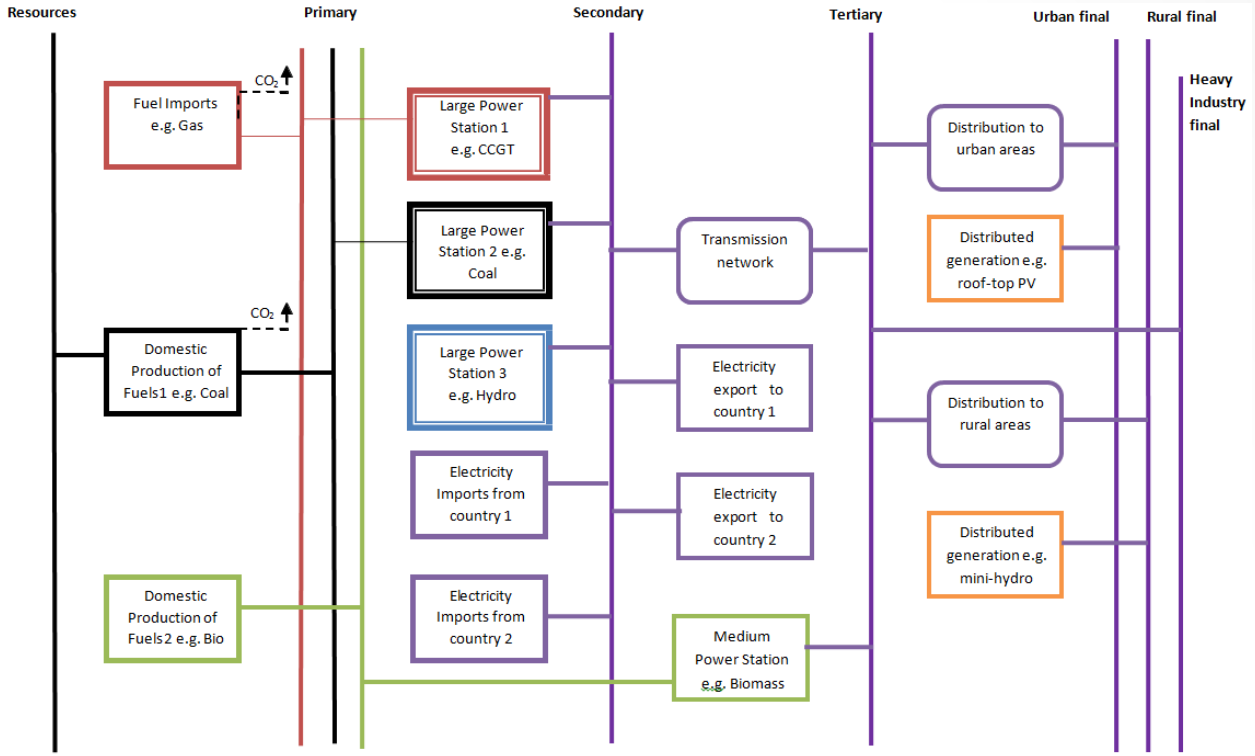
Industrial – Rural – Urban & commercial levels
African Energy Outlook (AEO) 2040 – calibrated to 2010 data

Load regions

Hourly data for Morocco & Egypt

THE MODEL

The reference energy system



- Each country is one node
- Transmission lines link each node
  - Existing & planned
  - ICA, WB & MED
- Natrual gas is traded between nodes and to Europe
- Includes around 200 techologies

THE MODEL

Scenario Development

Frozen future (FF)

- Local gas price (incl. subsidies)
- No improvement in technology performance
- No gas sale on international market
- Carbon mitigated valued at 25 USD/t

Progressive technology (PT) – builds on (FF)

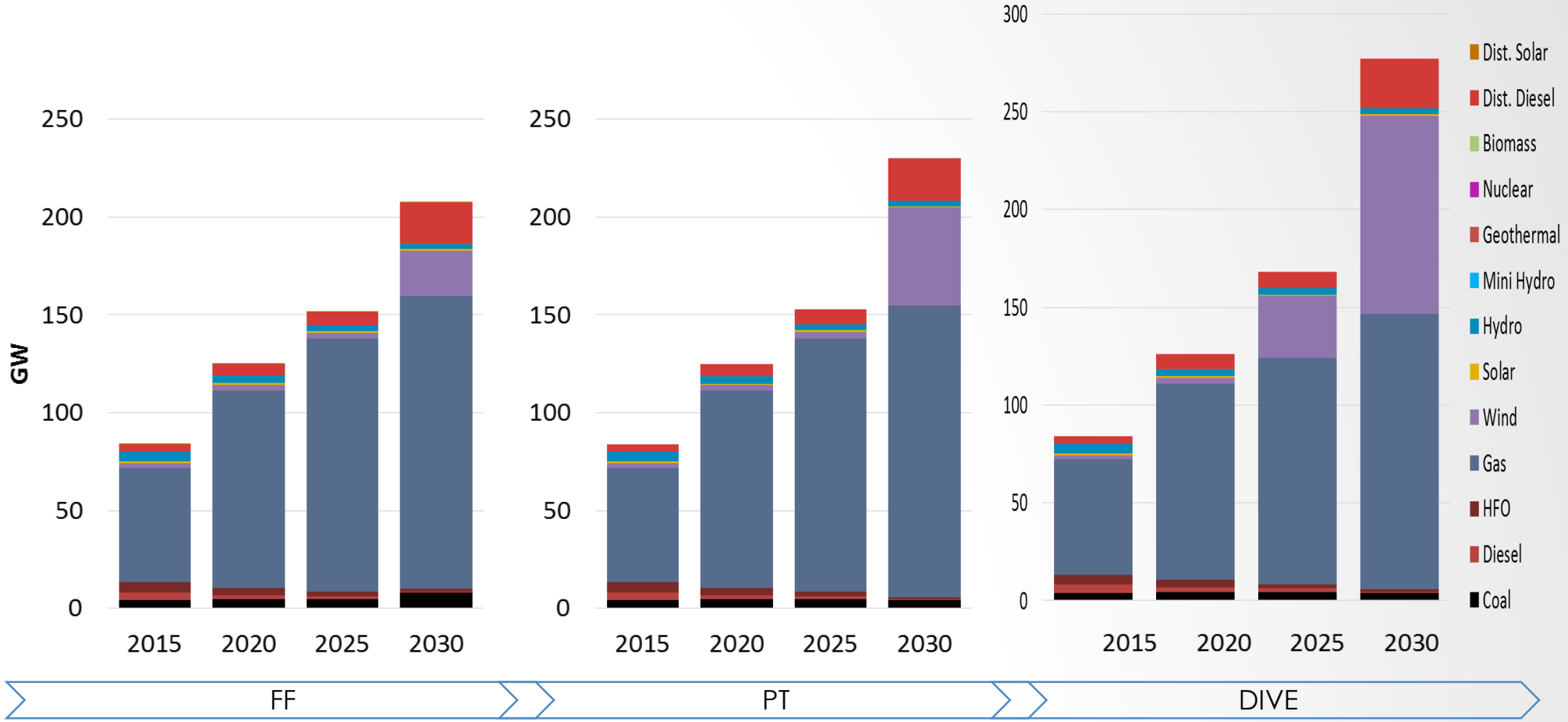
- Renewable Energy Technology (RET) capital costs improve
- Local gas prices are maintained: no opportunity cost of other fuel uses

Diversification and environmental investments (DIVE)

- Adopts progressive environmental economics
- Netback pricing of Natural Gas
- RET development continues, the region actively diversifies its generation portfolio.
- Includes futures with a range of CO_2 mitigation incentives from 25-50USD/t

RESULTS

Regional Capacity



RESULTS

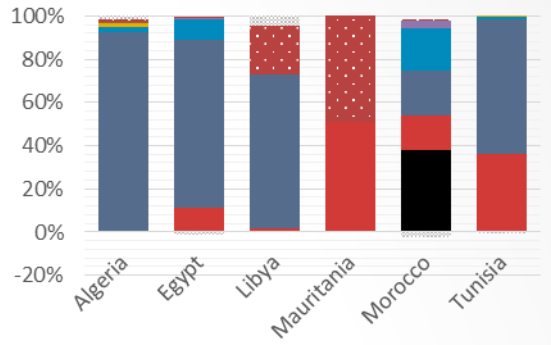
Generation

FF

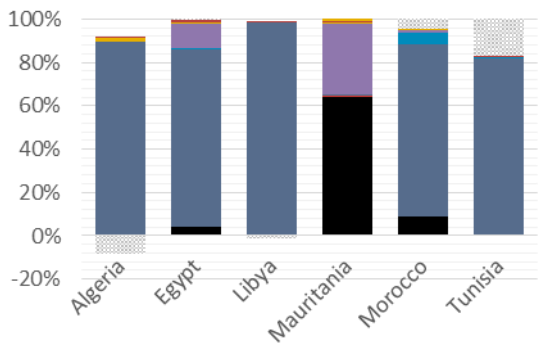
PT

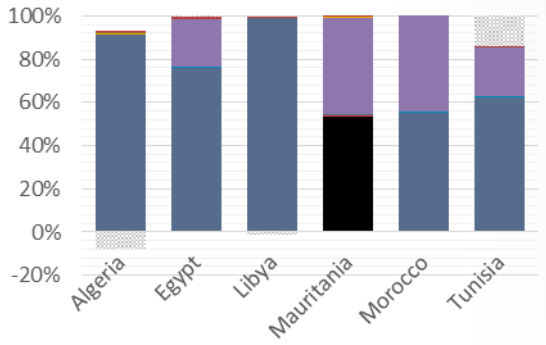
DIVE

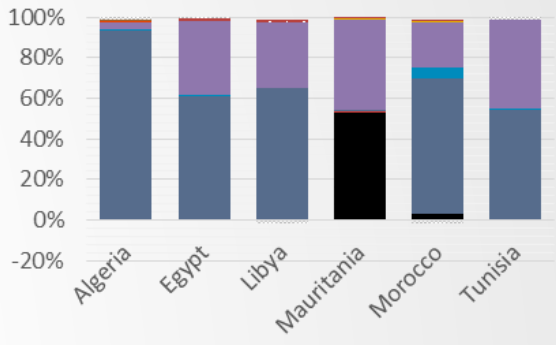
2010

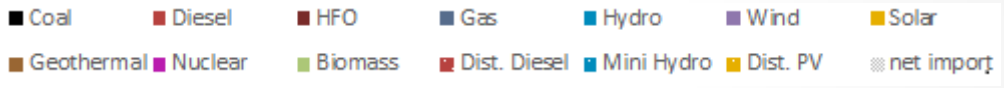


2030





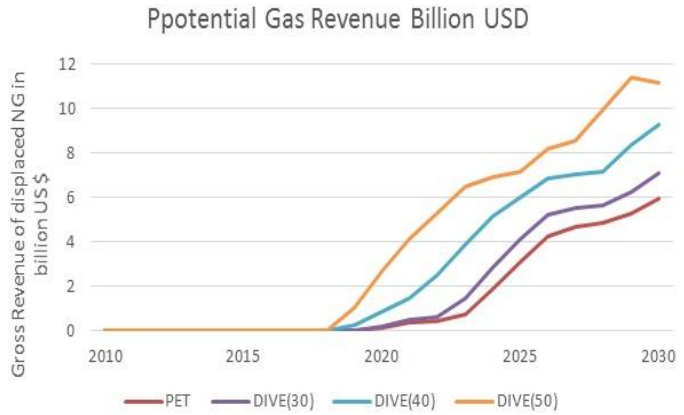


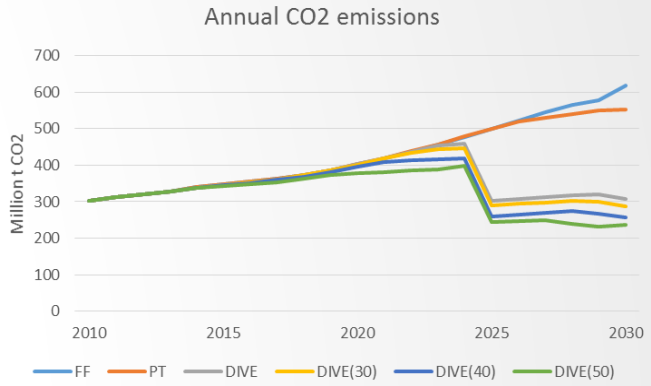


RESULTS

CO2 mitigation & Costs

- Potential revenue from NG increases with higher RE penetration
- Netback pricing
  - Increases the cost competitiveness of RET
  - Offsets higher annualised system costs by the sale of NG
  - Has a potential to help mitigate CO2 emissions





CONCLUSION

Food for thought

So far the analysis shows that

- Offseting natural gas & fossil fuel use with RET in NA is possible and can be economically sound
- Potential benefits
  - Economic for NA & Energy security for EU

And further steps would include

- Further load region detail – regional peak shift
- Including the natural gas network in the analysis
- Improve elements of cost data
- Constraints associated with intermittency

THANK YOU FOR YOUR ATTENTION

Division of dESA Energy Systems Analysis