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Abu Dhabi Integrated Energy Model (IEM) and Policy Framework

12 December 2019

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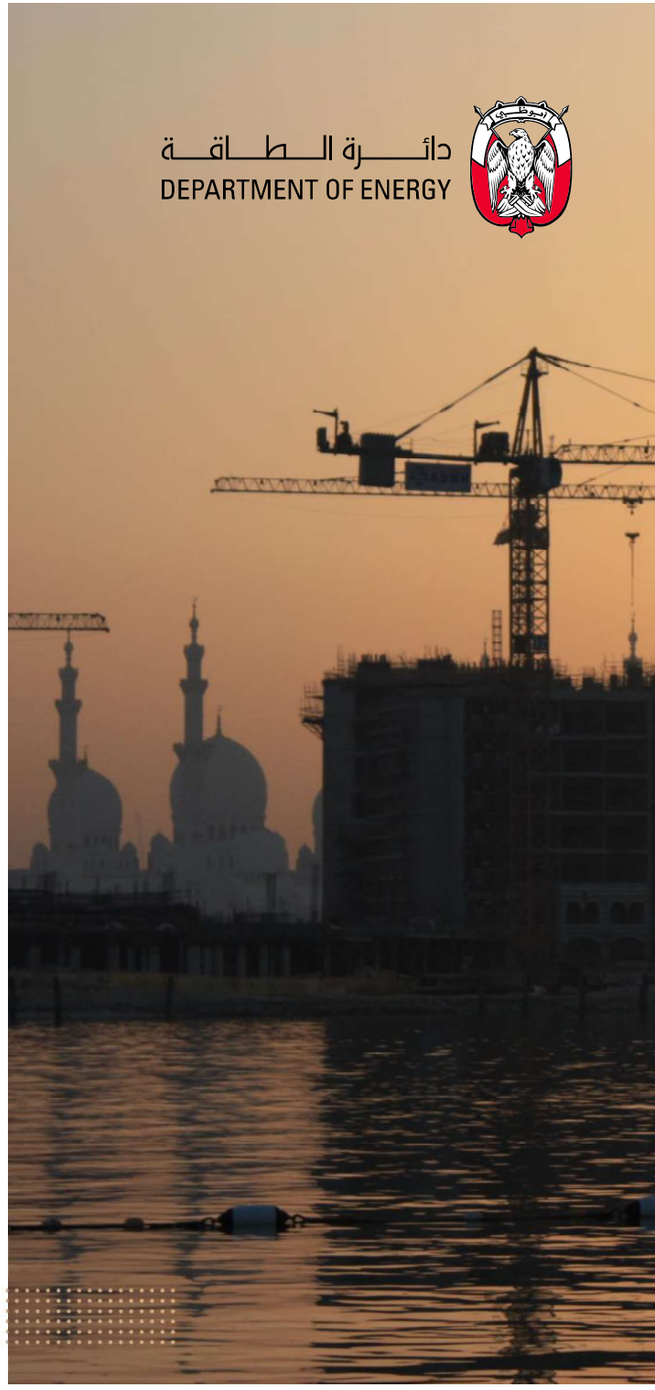

Abu Dhabi context – UAE composition

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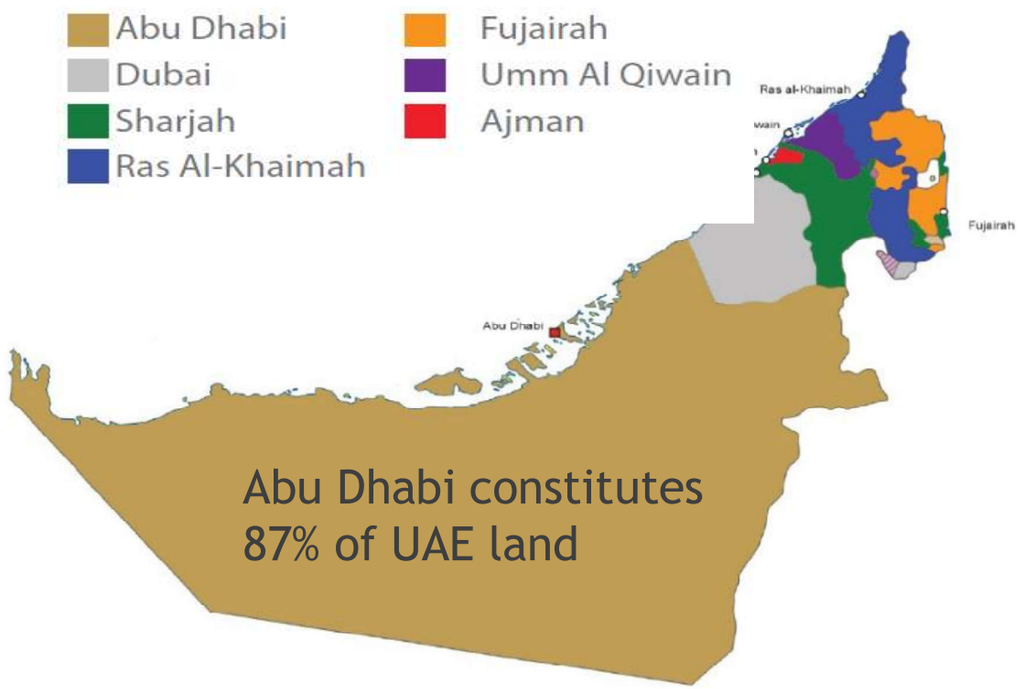
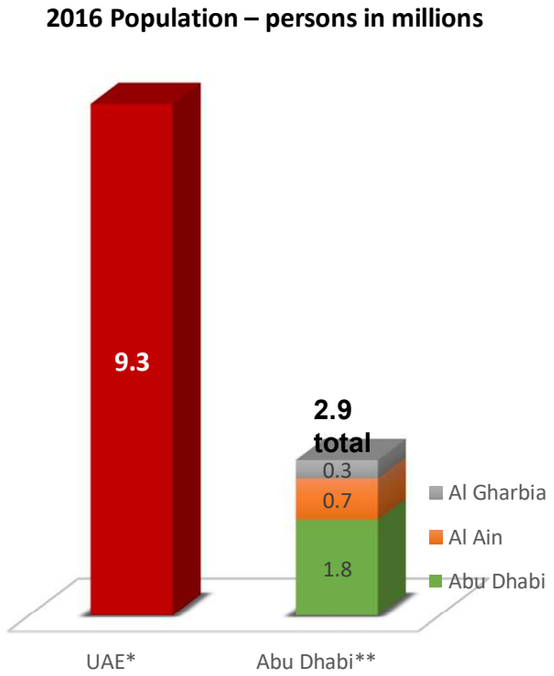
UAE has 7 Emirates, Abu Dhabi being the federal capital and largest Emirate

Abu Dhabi Emirate accounts for 30% of the UAE's population (2.9m out of 9.3m)





Source: Statistics Centre Abu Dhabi (SCAD)

Source:
*The World Bank – United Arab Emirates Data - 2016
**Statistics Centre Abu Dhabi (SCAD) – Statistical yearbook of Abu Dhabi – mid 2016 population

DoE has a broad Policymaking and Regulatory mandate for the energy sector in Abu Dhabi

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DoE Objective	Oversee the development and implementation of an integrated energy sector strategy for Abu Dhabi which benefits its broader economy and people

Set strategy

- **Set** and **align** on **priorities** for Abu Dhabi energy policy framework
- Coordinate the continuous **development** and **update** of the Abu Dhabi energy policy framework, including provision of objective complex analytics via **the integrated Energy Model i.e. the 'Energy Cube'**
- **Recommend** energy policies for Abu Dhabi

Provide oversight

- **Set interim objectives** and collectively agree on implementation timelines
- Oversee progress on **implementation** of the Abu Dhabi energy sector strategy
- Collaborate with stakeholders to Identify and unlock **bottlenecks** in the implementation process

Foster collaboration

- encourage all stakeholders to commit to providing necessary data and resources, deepen policy integration, and adopt the Energy Model and Framework roadmap.
- Ensure the **support** and **commitment** of all **stakeholder entities** of Abu Dhabi.
- **Coordinate with Federal bodies** for uniting resources and coordinating efforts between Abu Dhabi Emirate and the UAE Federal objectives

DoE Agenda driven from the Government Mandate and form the basis for the Integrated Policy Framework and Energy Model

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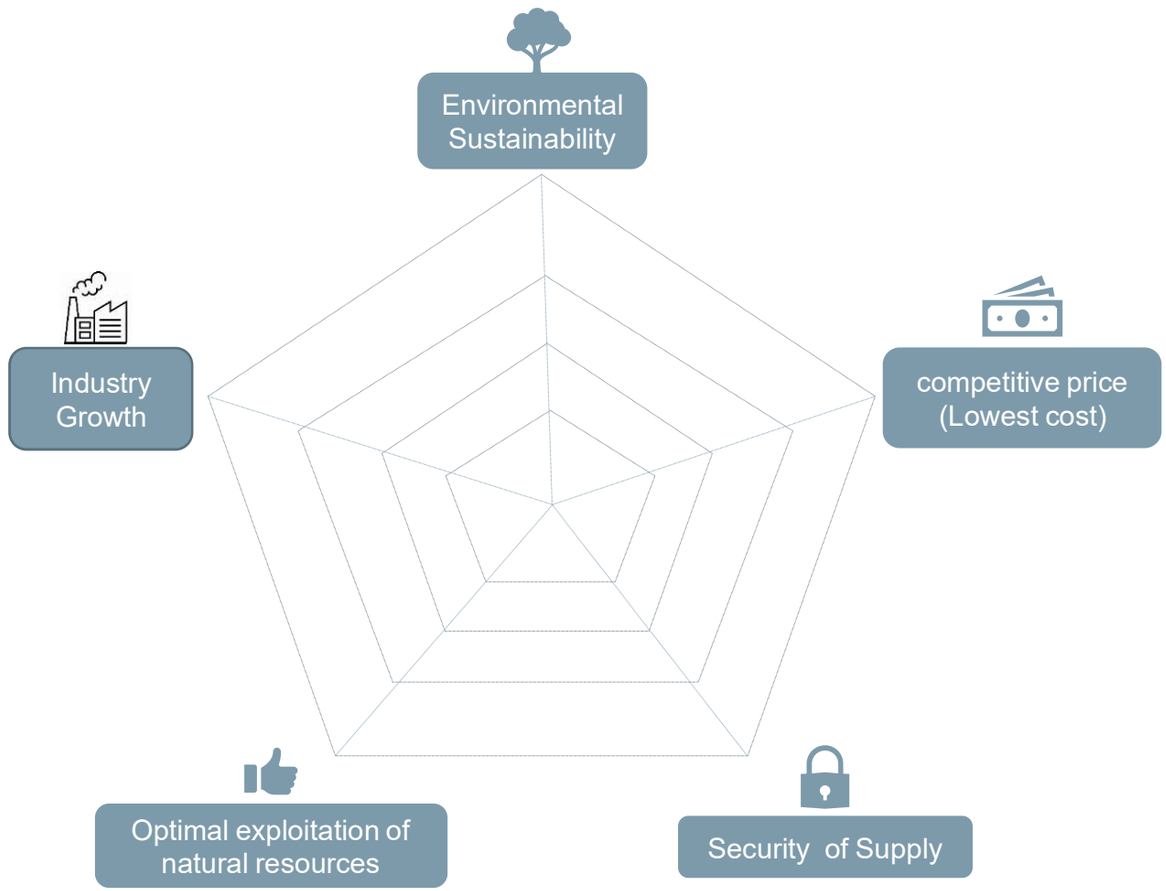
Security of Supply	Maintaining a **secure energy (gas) supply** is fundamental to providing stable and reliable energy to Abu Dhabi's robust economy.
Cost competitiveness	Optimizing **system costs** is the basis for an efficient energy system, and an optimized system would allow Abu Dhabi to make the best decisions on cost trade-offs.
Environmental Sustainability	Abu Dhabi has recognized the potential opportunities provided by diversifying its energy system towards **cleaner technologies** and has formulated ambitious policies to capitalize on this potential.
Industrial growth	Abu Dhabi's energy system strives to support the rapid development of key **non-oil industries** fundamental to Abu Dhabi's future economic growth.
Optimal exploitation of natural resources	Abu Dhabi continue to **optimize the full value of its natural resources** shifting from a primarily fossil-fuel-based economy with high energy and carbon intensity to a system with diversified energy sources.



DoE has structured and launched an integrated policy framework as a basis to develop specific policy elements together with our stakeholders

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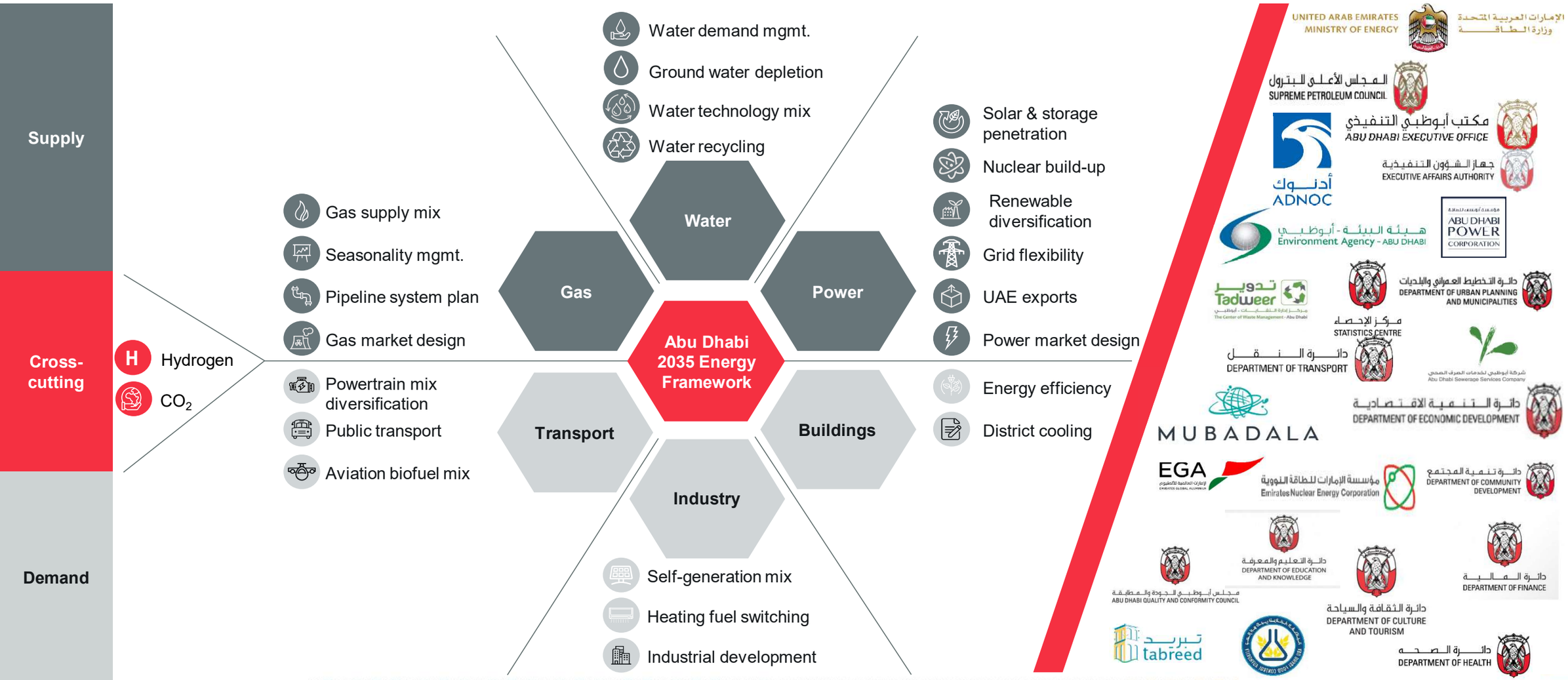

UNITED ARAB EMIRATES MINISTRY OF ENERGY
الإمارات العربية المتحدة وزارة الطاقة
المجلس الأعلى للبترول SUPREME PETROLEUM COUNCIL
مكتب أبوظبي التنفيذي ABU DHABI EXECUTIVE OFFICE
جهاز الشؤون التنفيذية EXECUTIVE AFFAIRS AUTHORITY
أدنوك ADNOC
هيئة البيئة - أبوظبي Environment Agency - Abu Dhabi
ABU DHABI POWER CORPORATION
تدوير Tadweer
دائرة التخطيط العمراني والبلديات DEPARTMENT OF URBAN PLANNING AND MUNICIPALITIES
مركز الإحصاء STATISTICS CENTRE
دائرة النقل DEPARTMENT OF TRANSPORT
شركة أبوظبي لخدمات الصرف الصحي Abu Dhabi Sewerage Services Company
MUBADALA
دائرة التنمية الاقتصادية DEPARTMENT OF ECONOMIC DEVELOPMENT
EGA
مؤسسة الإمارات للطاقة النووية Emirates Nuclear Energy Corporation
دائرة تنمية المجتمع DEPARTMENT OF COMMUNITY DEVELOPMENT
دائرة التعليم والمعرفة DEPARTMENT OF EDUCATION AND KNOWLEDGE
دائرة المالية DEPARTMENT OF FINANCE
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دائرة الثقافة والسياحة DEPARTMENT OF CULTURE AND TOURISM
تبريد tabreed
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The Energy Cube help solving for key elements of the policy framework

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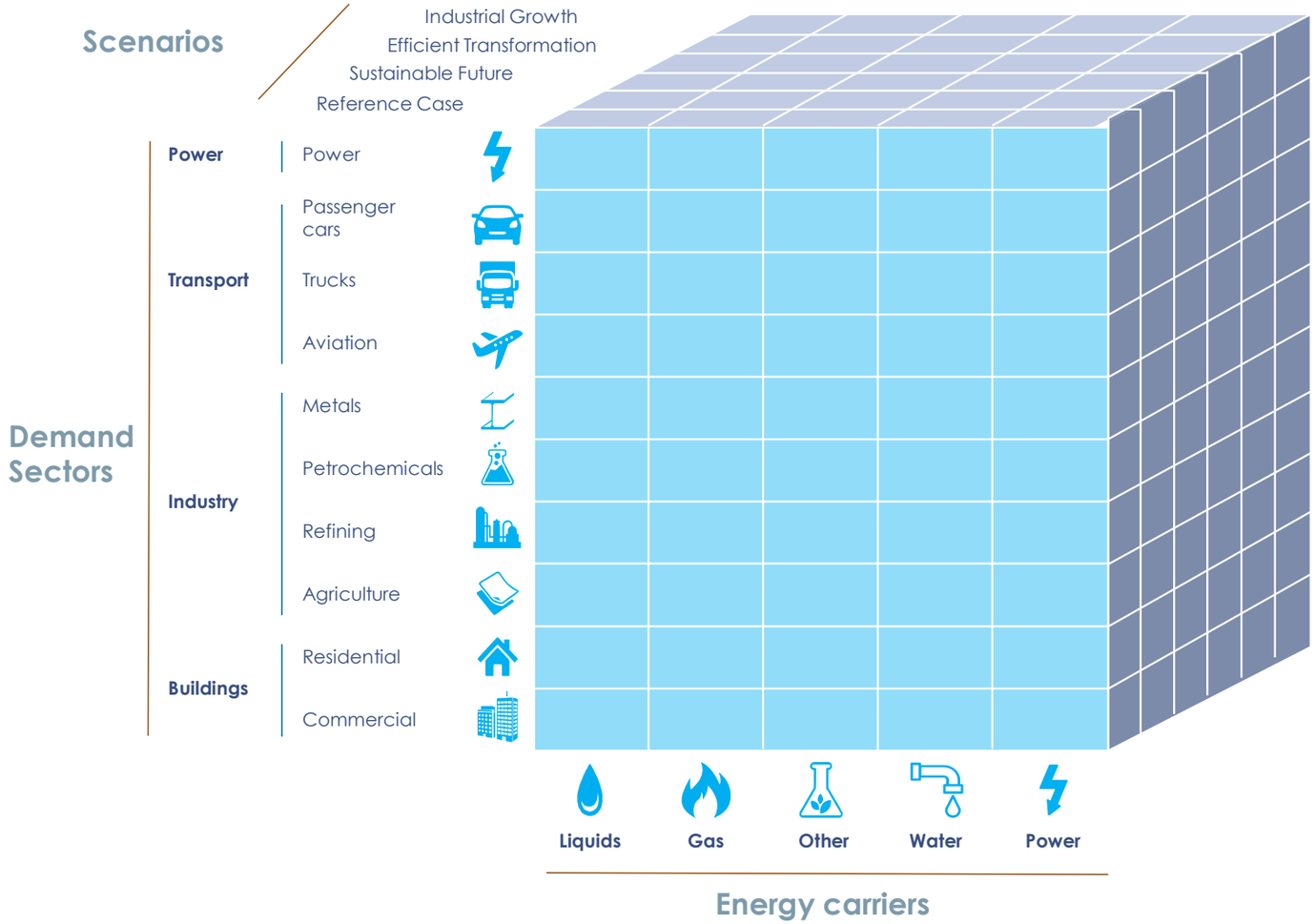
- The IEM helps solve and test for key elements of our proposed policy framework
- It provides an energy outlook for Abu Dhabi along 3 dimensions:
  - Energy demand sectors;
  - Energy carriers;
  - Visualizes possible future scenarios and trade-offs through comparable key metrics included but not limited to:
    - Energy Supply System Cost
    - Energy System CO_2 Emissions
    - Share of Gas Imported
    - Industrial Energy Demand
    - Oil and Gas Demand



The IEM architecture consists of 5 modules

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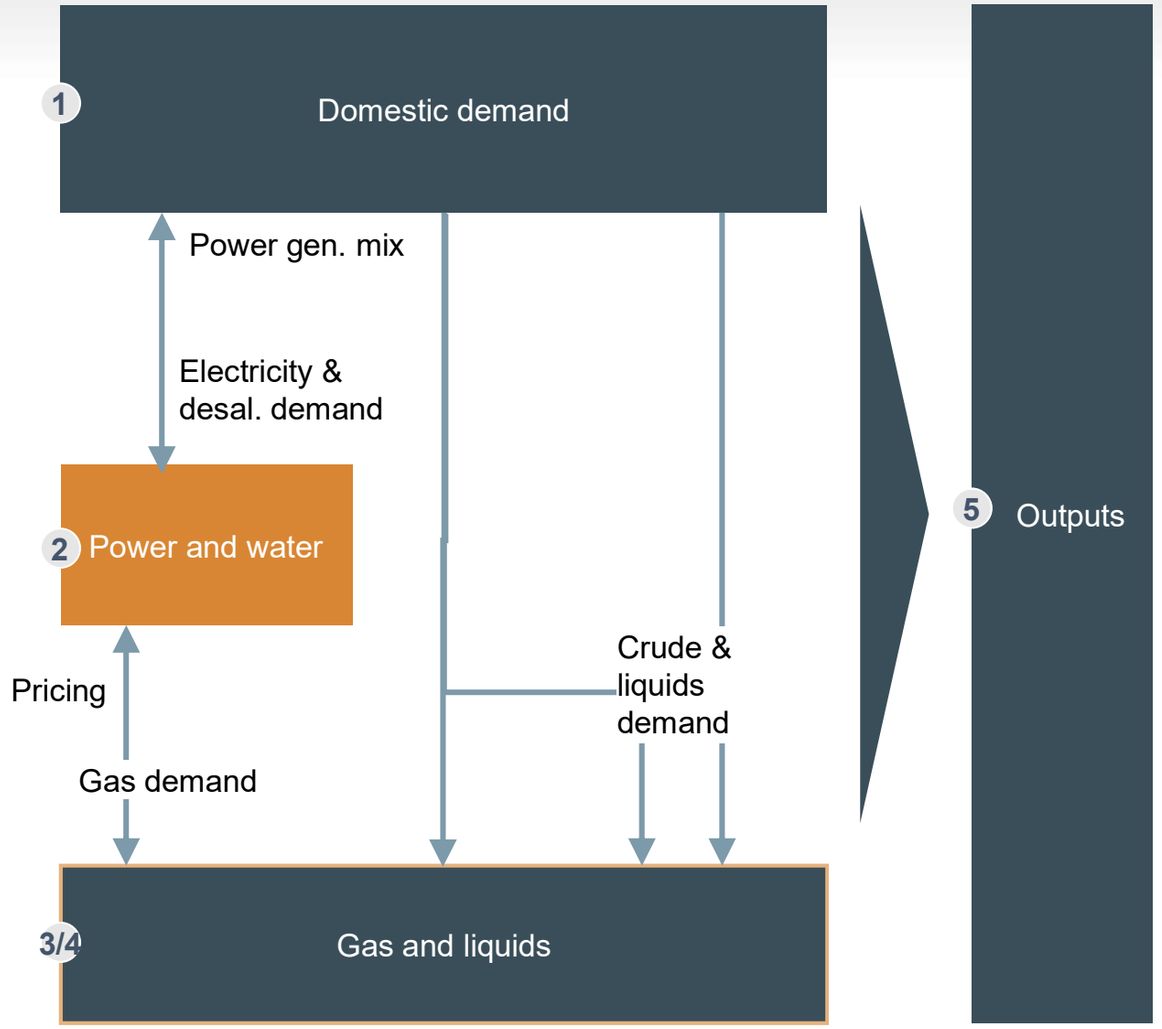
Model architecture



Module characteristics

1. **Energy and feedstock domestic demand projections** through bottom-up assessment for 14 sectors covering transport, buildings and industry
2. **Power and water generation module** based on Gurobi GPM solution, optimizes capacity additions based on electricity demand and economic/local constraints
3. **Gas balance module** determining domestic gas balance (yearly and monthly), linked to power and domestic demand, provides marginal cost and supply options
4. **Liquids balance module** determining available liquids export volumes vs. local consumption and field-level production
5. **Output module** assessing each energy sector scenario along the objective KPIs (e.g., CO2 emission, system cost impact)

Power Model optimizes capacity and generation mix based on the minimal total system cost objective

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Inputs

Abu Dhabi data

- **Annual demand** by sector and hourly **load curves**
- Hourly **solar radiation profiles**
- **Policies** and socio-economic constraints

Technology data

- Existing and planned **capacity** (new builds & retirements)
- Fixed perspectives for all technologies e.g. **nuclear, PV, co-gen fleet**
- Investment and operation **costs**
- **Technical characteristics** (e.g. lifetime, net efficiency, availability, derating factors)
- **Water cogeneration** based on minimal load factor, capturing historical seasonal fluctuations

Market data

- **Fuel prices** per year
- **Carbon prices** per year

Optimization

The engine will choose the best mix of levers regarding:

- **Investment**
- **Dispatch by technology**
- **Storage and DSR**

Outputs

Operational

- **Generation** mix
- **Emissions** outlook by technology
- **Demand by fuel**

Planning

- **Capacity** by technology
- Market size for **additions** and **retirements** by technology
- **Investments** by technology

Financial

- **LCOEs** by technology
- **Total system cost and marginal cost**

Challenges and expectations

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- Using IEM as a tool to inform policy design and decision-making
- In the context of VRE, DoE in its role of a regulator and policymaker, has a work stream to understand the impact of renewable generation, in particular Solar PV, in AD's energy system, which includes:
    - Impact of system flexibility needs, reserves and resource adequacy for different levels of penetration
    - System long-term planning and optimization (generation and transmission) to enable least cost solutions
    - Potential solutions, and how these may differ between centrally planned energy systems vs decentralized (market based) energy systems

Key challenges:

- Cogen fleet (significant base load)
- Seasonality

VRE integration:

- 1st phase: VRE is considered exogenously within the IEM architecture
- IEM to evolve to enable assessment of different VRE penetration levels on e.g. reserve needs, flexibility needs, resource adequacy, role of DER, market design, planning and optimization

Expectations:

- DoE keen to understand best practices in using spatial data/models to assess impacts of VRE penetration and design robust long-term scenarios in context of Abu Dhabi power system

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Thank you