Power Market Dynamics

Presented to: Energy & the Economy Meeting

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THE ENERGY INDUSTRY HAS CHANGED

- Price Volatility
- Geopolitical Climate
- Cost Inflation
- Capital Discipline
- Free Cash Flow
- ESG Impact
- Energy Diversification
- Global Pandemic
- Global Diversification
- Geopolitical Climate
- Cost Inflation
- Capital Discipline
- Free Cash Flow
- ESG Impact
THE HEADWINDS: A SUMMARY

WHAT WE SAY WE NEED FOR THE ENERGY EVOLUTION

- **Hydrocarbons ↓** | Need to decline at a rapid rate to meet Well Below 2°C ambitions.

- **Investment ↑** | Need public and private investment to fill in demand gaps with technology.

- **Collaboration ↑** | Global collaboration at levels never seen before.

- **Government Intervention ↑** | Global government intervention at levels never seen before.

WHAT WE NEED TO CONSIDER ABOUT THE ENERGY EVOLUTION

- **Hydrocarbons ↓** | Lack of investment will cause price volatility and shocks to world economies.

- **Infrastructure ↑** | Redundant infrastructure and early abandonment of existing infrastructure is costly.

- **Supply Diversification ↓** | Hydrocarbon production becomes more concentrated, making supply riskier.

- **Emissions ↓** | Efforts to reduce emissions require higher cost measures short term.

- **Digitalization ↑** | Digitalization of new and existing infrastructure and cybersecurity risk mitigation is costly.

- **Hydrocarbon Revenues ↓** | Hydrocarbon revenues decline, making resource-rich economies unstable.

- **Storage ↑** | Industrial-scale storage key to reliability of grids throughout the electrification.

- **Access ↑** | Need to address immediacy of access to electricity and clean cooking.

- **Mining ↑** | Require more minerals, which are concentrated in fewer countries with weak ESG practices.

- **End-Use ↑** | Need to address the energy needs of transport, industry, & buildings.

- **Financing ↑** | More financing for developing and emerging economies to address emissions.

- **Workforce ↑↓** | Changes in energy mix will impact workers and communities differently.
Government/regulatory policy shifts targeting climate objectives.

Preference shifting to energy use as electrons instead of heat.

Climate awareness is changing the investment landscape.

Increasing economic competitiveness of supply substitutes.

Source | Enverus
CONSUMER: PREFERENCE FOR ELECTRONS

Source | Enverus, IEA

2021

Oil: 103.16 EJ
Natural Gas: 146.15 EJ
Coal: 165.33 EJ
Power Sector: 241.35 EJ
Other: 129.62 EJ

Industry: 166.74 EJ
Transport: 113.43 EJ
Buildings: 139.11 EJ
Other Sector: 27.35 EJ
Losses/Storage: 177.63 EJ

Other Renewables: 3.09 EJ
Nuclear: 9.98 EJ
Coal: 26.72 EJ
Natural Gas: 23.39 EJ
Oil: 2.46 EJ
Wind: 6.72 EJ
Hydro: 15.62 EJ
Solar: 3.61 EJ

Electricity/Heat: 101.77 EJ

2050 Announced Pledges Scenario

Oil: 108.44 EJ
Natural Gas: 82.04 EJ
Coal: 47.34 EJ
Power Sector: 349.16 EJ
Other: 381.27 EJ

Industry: 173.75 EJ
Transport: 112.48 EJ
Buildings: 122.00 EJ
Other Sector: 63.34 EJ
Losses/Storage: 157.45 EJ

Other Renewables: 20.35 EJ
Nuclear: 18.37 EJ
Coal: 9.34 EJ
Natural Gas: 14.05 EJ
Oil: 0.63 EJ
Wind: 82.89 EJ
Hydro: 27.15 EJ
Solar: 67.03 EJ

Electricity/Heat: 239.36 EJ

+116.5%
1988 | Global warming hit the mainstream as summer temperatures were the hottest on record to date.

1988 | The IPCC is created to study climate change and potential response strategies in the future.

1997 | Kyoto Protocol & 2015 | Paris Agreement set broad policy framework to address climate concerns.

Today | Countries are developing and implementing policies to meet national & international commitments.

Next | Tracking progress towards goals to evaluate the impact of policies will be crucial to climate outcomes.

Source | Enverus
POLITICAL: AMBITION REQUIRES EVALUATION

Stated Policies Scenario

Announced Pledges Scenario

Net Zero Emissions by 2050 Scenario

Source: Enverus, IEA
MICROECONOMIC: COMPETING INVESTMENTS

FIGURE | Energy Technology Economics Comparison

Assumptions | 2023/24 Vintage | Oil & Gas : $60 WTI/$3 HH | Generation: $40/MWh | Storage: LTM Combo Strategy | Hydrogen: $1.50/kg, No Transport | EV: 5% Utilization
24/7 RENEWABLES | THE PROBLEM

Avg Hourly Net Gen by Technology (Jan 2022-Oct 2023)

Source: Enverus, Balancing Authorities, EIA

Net Generation (GWh) by Technology:
- Total
- Coal
- Natural Gas
- Nuclear
- Petroleum Products
- Hydro & Pumped Storage
- Solar
- Wind

Avg Hourly Net Gen by Technology (Jan 2022-Oct 2023)

- Total: 39%
- Natural Gas: 39%
- Nuclear: 19%
- Petroleum Products: 7%
- Solar: 4%
- Wind: 2%
- Other: 10%

Hour Ending (Local Time): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
24/7 RENEWABLES | WHAT ARE WE DOING?

Avg Hourly Net Gen by Technology (Jan 2022-Oct 2023)

Capacity Operating and in Queues by Technology

Source: Enverus P&R – Project Tracking, Balancing Authorities, EIA
STORAGE | RETURNS LOOK GOOD FOR NOW...

FIGURE | Storage Strategy Returns Benchmarking

Source: Enverus P&R – Economics, Enverus Intelligence
STORAGE | ...ARBITRAGE EATS ITS OWN TAIL...

FIGURE | Duration Impact on Returns

Source: Enverus P&R – LMP, Enverus Intelligence
STORAGE | ...AND LONG-DURATION IS FAR FROM ECONOMIC.

FIGURE | Achievable and Breakeven Spreads by ISO

Source: Enverus P&R – LMP, Enverus Intelligence
CURRENT STATE OF NYISO

NYCA Energy Production by Source

2022 Production GWh
- Nuclear: 26,883
- Hydro: 27,354
- Wind: 4,825
- Solar: 110
- Other Renewables: 2,368
- Oil: 143
- Dual Fuel (Gas/Oil): 53,547
- Gas: 10,913

TOTAL: 126,144

Upstate Energy (Zones A-E)

2022 Production GWh
- Nuclear: 30,883
- Wind: 2,405
- Other Renewables: 969
- Gas: 1,057
- Dual Fuel (Gas/Oil): 517

TOTAL: 62,659

Downstate Energy (Zones F-I)

2022 Production GWh
- Nuclear: 6,855
- Coal: 154
- Solar: 131
- Other Renewables: 1,459

TOTAL: 63,140
NYISO | 70X30 MANDATE – WITH WHAT TECHNOLOGIES?

FIGURE | Optimal Installed Capacity by Type

Source: Enverus Intelligence

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NYISO | 70X30 MANDATE – WHAT A WASTE

FIGURE | Average Generation Profile for 100% Carbon Free Renewable Energy

Source: Enverus Intelligence
NYISO | 70X30 MANDATE – AT WHAT COST?

FIGURE | Cost of Flexibility in NY Power System

Source: Enverus Intelligence

$1.00
$0.90
$0.80
$0.70
$0.60
$0.50
$0.40
$0.30
$0.20
$0.10
$0.00

Total Retail Cost ($/kWh)

% of Gas-Fired Generation

100% Clean Renewable Mix
100% Clean CC Mix
70% Clean CLCPA Mix
70% Clean NYISO Mix
70% Clean Economic Mix
X% Clean Economic Mix
X% Clean Queue Mix

R² = 0.8353

% 0% 5% 10% 15% 20% 25% 30% 35% 40% 45% 50%

2030 Scenarios
2022 Average

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There were ~760 Million people without access to electricity in 2020.

There were ~2.4 Billion people without access to clean cooking in 2020.
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Hydrocarbon Revenues ↓ | Hydrocarbon revenues decline, making resource-rich economies unstable.

Storage ↑ | Industrial-scale storage key to reliability of grids throughout the electrification.

End-Use ↑ | Need to address the energy needs of transport, industry, & buildings.

Access ↑ | Need to address immediacy of access to electricity and clean cooking.

Mineral Revenues ↓ | Hydrocarbon revenues decline, making resource-rich economies unstable.

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Mining ↑ | Require more minerals, which are concentrated in fewer countries with weak ESG practices.

Access ↑ | Need to address immediacy of access to electricity and clean cooking.

Government Intervention ↑ | Global government intervention at levels never seen before.

Workforce ↑↓ | Changes in energy mix will impact workers and communities differently.
THANK YOU!

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