

EVOLVING ROLE OF THE THERMAL FLEET IN THE CLEAN ENERGY TRANSITION

AES INDIANA IRP STAKEHOLDER WORKSHOP #4

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BHAWRAMAETT BROEHM
WÄRTSILÄ NORTH AMERICA
BHAWRAMAETT.BROEHM@WARTSILA.COM

WÄRTSILÄ IN A NUTSHELL



74 GW

Power plant capacity delivered to **180** countries

12,000

Engines delivered across **5,000** power plants

100

Power plants delivered in the USA

180

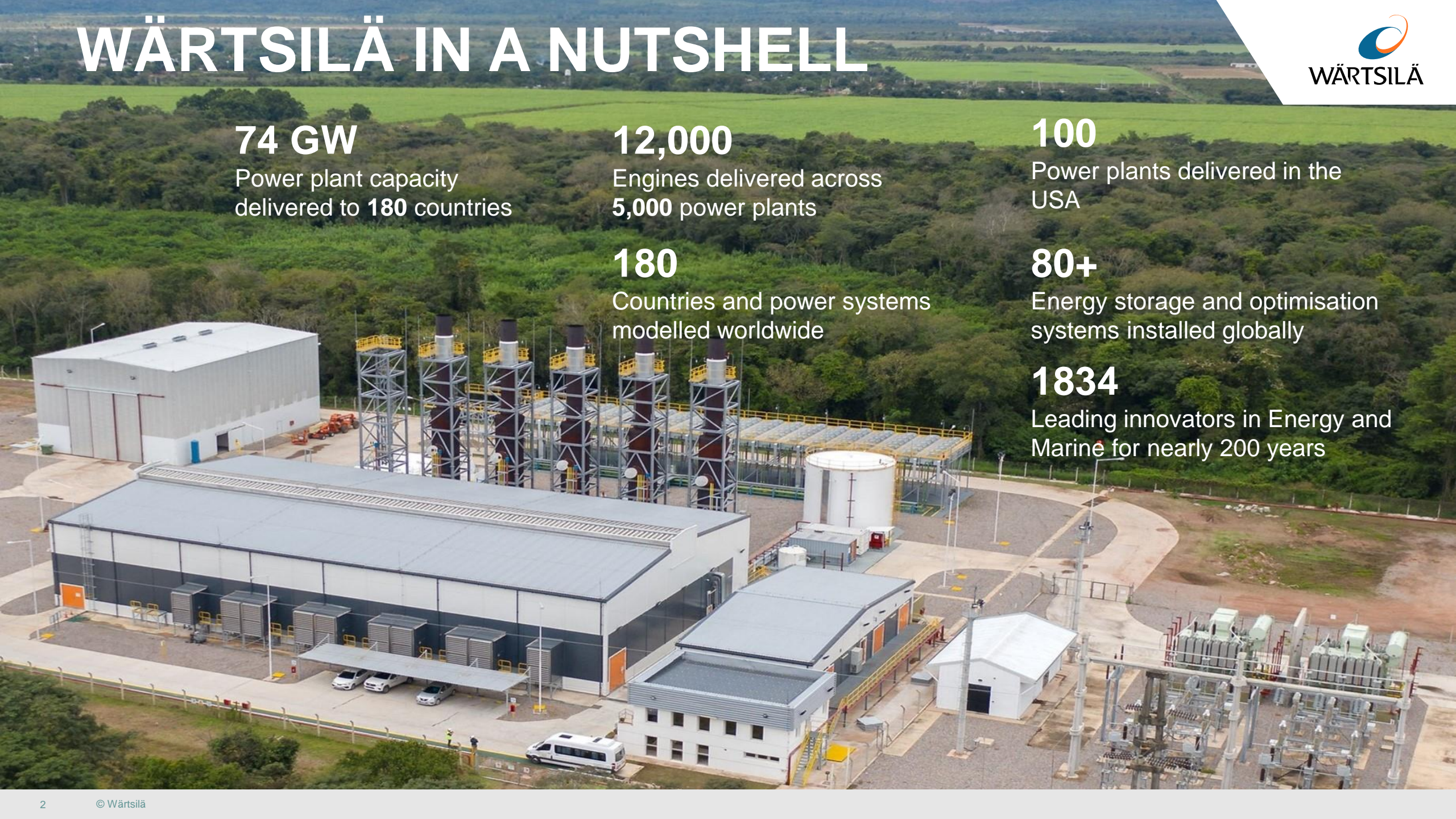
Countries and power systems modelled worldwide

80+







Energy storage and optimisation systems installed globally

1834

Leading innovators in Energy and Marine for nearly 200 years



FLEXIBLE, RESILIENT GENERATION FOR TODAY & TOMORROW

-  **Responsive** – Synchronized to grid in 30 seconds, full power in a little as 90 seconds, AS capable, low minimum operating level, no start costs, no minimum uptimes or downtimes
-  **Resilient** – Operates on low gas pressure, supports areas “islanded” by transmission outages, provides black start capability during system emergencies (i.e., extreme weather)
-  **Quick-start** – Start and stop as many times needed, no impact on maintenance
-  **Modular** – unit size of 9 – 18 MW promotes redundancy and minimizes forced outage rates
-  **Efficient** – Fuel efficiency and output stable regardless of operating level or ambient temperature
-  **Minimal water** – Uses about one gallon/week

FLEXIBLE, RESILIENT GENERATION FOR TODAY & TOMORROW



Fuel Resiliency – Ability to use multiple fuel types capable of online switching and operating with low or fluctuating gas pressures without impacting generator output



Fuel Flexible – Capable of using different fuels, including green future fuels for multi-day & seasonal storage

- Natural Gas
- Fuel Oil
- Ammonia
- Hydrogen Blends
- Biodiesel
- Methanol

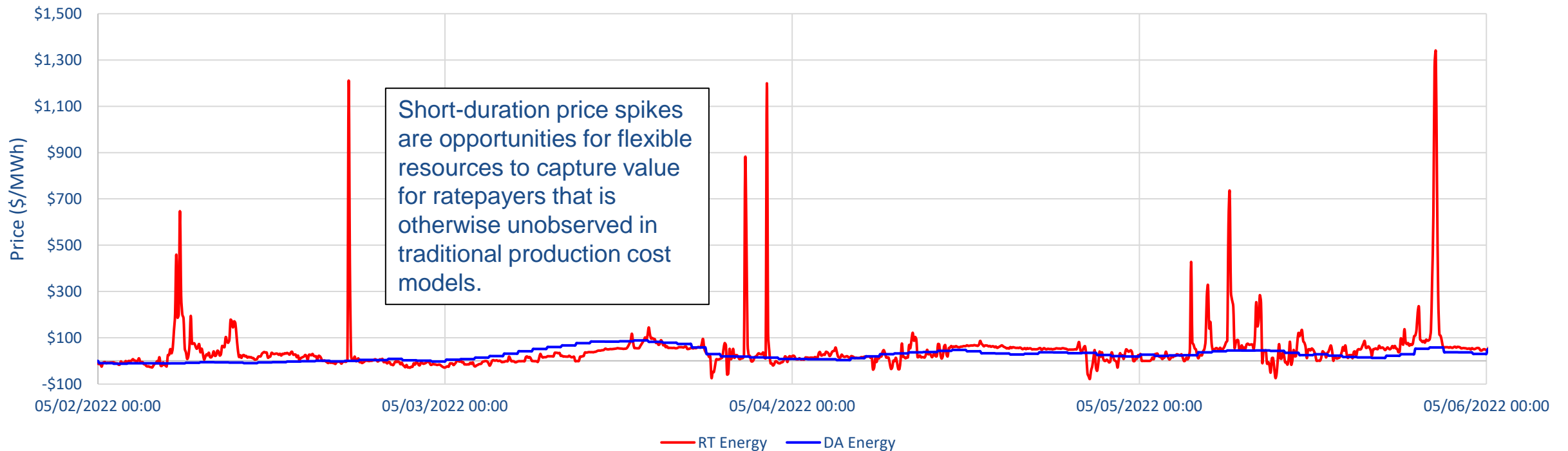


Practical & Future-Proof – Scalability of units capable of running on many different fuel types in extreme conditions makes these units an ideal grid solution.

Diving Deeper into Real-Time Power Systems

- Wärtsilä partnered with Ascend Analytics to study how dispatching resources to more volatile 5-minute prices uncovers the flexibility value of reciprocating engines compared to more traditional gas turbines.
 - Determine the “flexibility premium” realized in real-time market operations

Price Volatility at Representative Price Node in SPP



Quantifying Benefits of Real-Time Flexibility

Calculation of Net Present Value of Market Revenues less Costs (Variable & Fixed)*

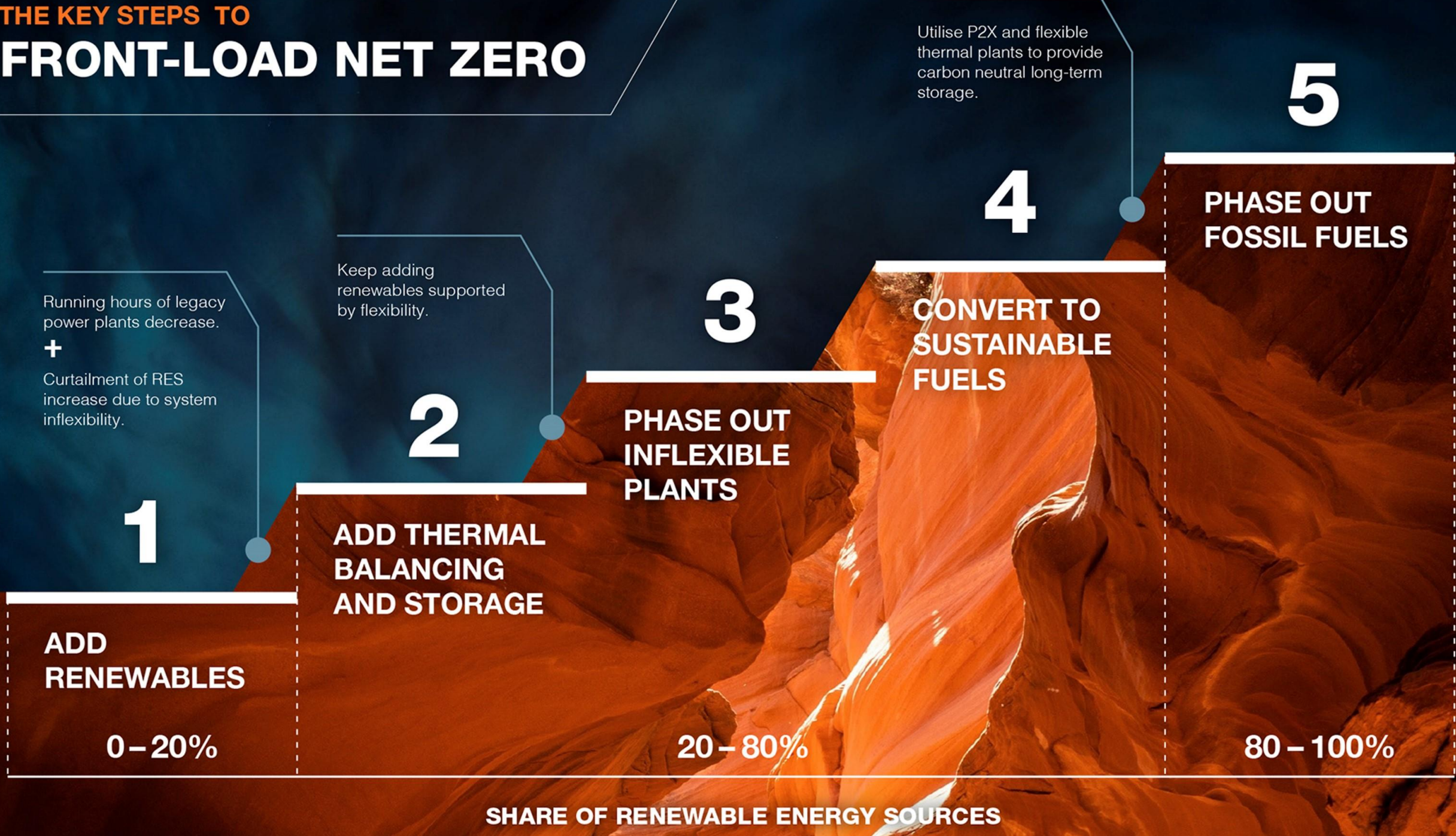
	A. DA Only (\$M)			B. 5-Minute Dispatch (\$M)			C. Residual Revenue Requirement (\$M) [A+B]		
Tech	RICE	AERO	HDGT	RICE	AERO	HDGT	RICE	AERO	HDGT
20 Year NPV**	(\$159)	(\$129)	(\$125)	\$93	\$57	\$23	(\$66)	(\$72)	(\$102)

- The addition of 5-minute dispatch to the model shows that more flexible RICE units are the least-cost resource
 - 5-minute dispatch uncovered an additional **\$93M of “hidden value.”**
 - The AERO and HDGT also have sub-hourly value, but much less than the RICE units (\$57M and \$23M of additional value, respectively)
 - The AEROs and HDGTs have start-up costs and longer min up/min down times. RICE units have no start costs and no min up/down times.

*Values are from an analysis in SPP, but similar directional conclusions can be made regarding sub-hourly value of flexibility in MISO due to comparable levels of variable renewable energy resources in their respective systems.

**Negative values represent utilities’ revenue requirement outside of day-ahead/real-time energy markets

THE KEY STEPS TO FRONT-LOAD NET ZERO



1

ADD RENEWABLES

0-20%

2

ADD THERMAL BALANCING AND STORAGE

20-80%

3

PHASE OUT INFLEXIBLE PLANTS

4

CONVERT TO SUSTAINABLE FUELS

5

PHASE OUT FOSSIL FUELS

80-100%

SHARE OF RENEWABLE ENERGY SOURCES

Key Takeaways

- RICE units have valuable characteristics for renewable integration
 - Fast ramping and efficient
 - No start-up or shut-down costs
 - No min-up or min-down times
- Utilizing sub-hourly modeling in high renewable systems ensures the most appropriate generation resources are chosen to keep costs low and reliability high



Key Takeaways

- **As utilities add more variable resources, the benefit to ratepayers of RICE technology will continue to grow.**
 - The value of RICE units relative to turbines increases as load, renewable generation, and price volatility grow (more efficient and can turn off as needed)
- **Utilities should:**
 - Model their power systems sub-hourly
 - Factor flexibility benefits – both costs and carbon – into resource planning and procurement decisions (i.e., add flexibility premium)





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