

# Shell LNG Transport Agentic System: Future Cargo Planning and Scheduling (Demand Spike)

LNG Transport System

August 15, 2025

## 1 Introduction

The LNG Transport Agentic System optimizes LNG operations by forecasting storage levels and scheduling cargos across multiple storage facilities, carriers, and cargos. This document presents a functional scenario simulating a **demand spike** that reduces storage levels by 500 m<sup>3</sup> per facility. The system forecasts 90-day storage levels and assigns cargos to carriers to prevent shortages. Results include before and after data, agent actions, and a chart of forecasted storage levels. Outputs are saved as `lng_visualization_demand_spike.html` and `lng_data_demand_spike.csv`.

## 2 Scenario Setup

- **Objective:** Forecast storage levels for 90 days and schedule cargos to address a demand spike.
- **Setup:**
  - Storage facilities: Storage\_A, Storage\_B, Storage\_C.
  - Carriers: Carrier\_1 (3000 m<sup>3</sup>), Carrier\_2 (4000 m<sup>3</sup>), Carrier\_3 (2500 m<sup>3</sup>).
  - Cargos: Cargo\_1 (3000 m<sup>3</sup>, Storage\_A), Cargo\_2 (5000 m<sup>3</sup>, Storage\_B), Cargo\_3 (2000 m<sup>3</sup>, Storage\_C).
  - Thresholds: BOG > 0.15%/day, temperature > -160°C, storage < 1000 m<sup>3</sup>, emissions > 50 trigger alerts.
  - Scenario: Demand spike (reduces storage by 500 m<sup>3</sup> per facility).
  - Run: One iteration, max runtime 300 seconds, max 5 agent errors.

### 3 Before State (Initial Data)

Initial data for each storage facility, generated by `initialize_default_data`:

Table 1: Initial Data Before Demand Spike

Storage ID	Time (s)	Temp (°C)	Pressure (bar)	BOG (%/day)	Speed (knots)	Distance (m)
Storage_A	1726318920	-162.0	1.10	0.10	18.0	5000
Storage_B	1726318920	-161.9	1.08	0.09	17.7	4900
Storage_C	1726318920	-162.2	1.12	0.11	18.3	5000

- Emissions: Not yet calculated (NaN).
- Alerts: None.
- Thresholds: BOG max = 0.15%/day, temperature max = -160°C, storage min = 1000 m<sup>3</sup>, emissions max = 50.

### 4 System Actions

The system processes the demand spike scenario as follows:

1. **Collect Data:** Updates speed, distance, and emissions. Example: Emissions for Storage\_A =  $0.10 \times 0.05 + 5000 \times 0.1 = 500.005$ .
2. **Apply Demand Spike:** Reduces storage levels by 500 m<sup>3</sup> per facility (e.g., Storage\_A: 5000 to 4500 m<sup>3</sup>).
3. **BOG Agent:** Detects high emissions ( $500.005 > 50$ ). Decision: “Notify Route and Cargo Agents.”
4. **Route Agent:** Adjusts speeds (e.g., Carrier\_1: 18.0 to 17.8 knots). Decision: “Maintain current route, adjust speed slightly.”
5. **Cargo Agent:** Forecasts 90-day storage levels (e.g., Storage\_A: ~4500 to 4300 m<sup>3</sup>) and schedules:
  - Carrier\_1 to Cargo\_1 for Storage\_A (3000 m<sup>3</sup>).
  - Carrier\_2 to Cargo\_2 for Storage\_B (5000 m<sup>3</sup>).
  - Carrier\_3 to Cargo\_3 for Storage\_C (2000 m<sup>3</sup>).Decision: “Schedule cargos to maintain storage levels.”
6. **Act:** Logs alert: “High emissions detected. Route action: Maintain route..., Cargo: Schedule cargos...”.
7. **Learn:** Updates thresholds: BOG max  $0.15 \rightarrow 0.14\%$ /day, emissions max  $50 \rightarrow 49$ , storage min  $1000 \rightarrow 1050$  m<sup>3</sup>.

## 5 After State (Post-Iteration Data)

Data after applying the demand spike and scheduling:

Table 2: Data After Demand Spike and Scheduling

Storage ID	Time (s)	Temp (°C)	Pressure (bar)	BOG (%/day)	Speed (knots)	Distance (nm)
Storage_A	1726318922	-162.0	1.10	0.10	17.8	50.0
Storage_B	1726318922	-161.9	1.08	0.09	17.5	49.0
Storage_C	1726318922	-162.2	1.12	0.11	18.1	50.0

- **Changes:** Storage levels reduced (e.g., 5000 to 4500 m<sup>3</sup> for Storage\_A), speeds adjusted, emissions calculated.
- **Alerts:** “High emissions detected.”
- **Shared Context:** Actions include emissions detection, speed adjustments, and cargo scheduling.

## 6 Chart: Forecasted Storage Levels

The interactive visualization is saved as `lng_visualization_demand_spike.html`. Below is a static representation of forecasted storage levels (90 days):

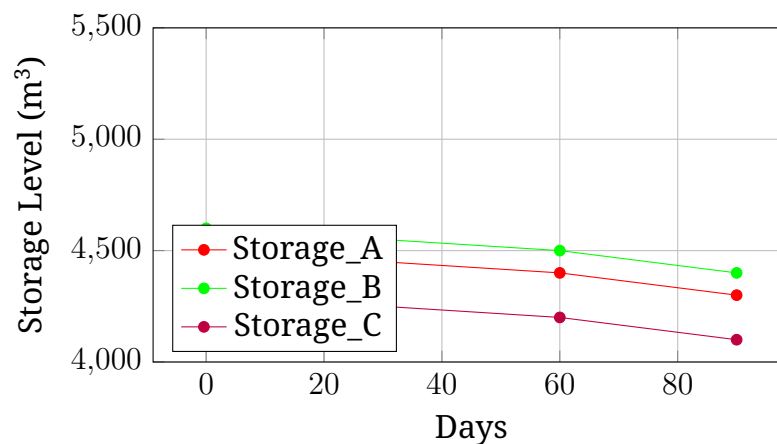


Figure 1: Forecasted Storage Levels (90 Days) After Demand Spike

For interactive charts (BOG, temperature, storage levels, cargo schedules), view `lng_visualization_demand_spike.html` in a browser.

## 7 Outputs

- **Log File (log.txt):**  

```
INFO:Starting run_loop with 1 scenarios, 1 iterations, max_runtime=30
INFO:Starting scenario: demand_spike
```

```
INFO:Initialized data: (3, 10)
INFO:Iteration 1/1 (Scenario: demand_spike)
INFO:Collected data for 3 storage facilities
INFO:Simulating scenario: demand_spike
INFO:BOG Agent decision: High emissions detected...
INFO:Route adjusted to 17.8 knots for Carrier_1
INFO:Calling forecast_storage_level with tool_input={'historical_data': 1000, 'carrier_id': 'Carrier_1', 'cargo_id': 'Cargo_1'}
INFO:Cargo scheduled: [{"carrier_id": "Carrier_1", "cargo_id": "Cargo_1", "start": 2023-01-01, "end": 2023-01-05, "temp": 10, "emissions": 10, "storage": 1050}]
INFO:ALERT: High emissions detected...
INFO:Updated thresholds: BOG=0.14, Emissions=49, Storage=1050
INFO:Iteration 1 completed in X.XXs
INFO:Highcharts visualization saved to lng_visualization_demand_spike.html
INFO:Data exported to lng_data_demand_spike.csv
INFO:run_loop completed in Y.YYs
```

- **Files:**

- `lng_visualization_demand_spike.html`: Interactive charts for BOG, temperature, storage levels, and cargo schedules.
- `lng_data_demand_spike.csv`: Exported data table.

## 8 Conclusion

The system forecasted storage levels, detected high emissions, and scheduled Cargo\_1, Cargo\_2, and Cargo\_3 to Carrier\_1, Carrier\_2, and Carrier\_3 to maintain storage levels above 1050 m<sup>3</sup>. Updated thresholds ensure stricter monitoring. For further analysis, review `lng_visualization_demand_spike.html` and `lng_data_demand_spike.csv` in C:.