Improvements in Emissions Modeling for Source Categories with Significant Ozone Precursor Emissions

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Area Source Analysis Focus

- 1996 VOC emissions Statewide >10 tpd by source category
  1. Commercial and consumer solvents
  2. Architectural surface coating
  3. Degreasing (solvent cleaning)
  4. Automotive refinishing (mobile equipment repair and refinishing)
  5. Gasoline marketing - service stations

Nonroad Analysis Focus

- Nonroad gasoline
- Nonroad diesel
- Aircraft
- Marine vessels
- Railroads
- Non-road other

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SOLVENT GREEN	EXIT STAGE 1	CONSUMER SURPLUS	DE-GREASE	PAINT BY ACRONYM	BEFORE AND AFTER
$100	$100	$100	$100	$100	$100
$200	$200	$200	$200	$200	$200
$300	$300	$300	$300	$300	$300
$400	$400	$400	$400	$400	$400
$500	$500	$500	$500	$500	$500

Criteria for Evaluating Area Source Emission Factors

- Quality and availability of activity data
- Methods used in neighboring States
- Ability to reflect solvents used in the inventory year
- Consistency/compatibility with national VOC rule requirements
- Ability to reflect future emission changes via State regulation

Area Source VOC Category	Recommended lb per capita EF (1996)	Day-of-Week Factor	Seasonality Factor
Consumer Products	7.84	7/7	1
AIM Coatings	6.70	7/7	1.3
Solvent Cleaning		7/5	1
Cold Cleaning – Auto Repair	2.5	7/5	1
Cold Cleaning – Other	1.1	7/5	1
Vapor/In-line Cleaning – Electronics	0.21	7/5	1
Vapor/In-line Cleaning – Other Mfg.	0.49	7/5	1
Mobile Equipment Repair and Refinishing	2.3	7/5	1

Service Stations - Recommended VOC Emission Factors

Emission Source	lbs/1000 gallon throughput EF
Filling underground tank (Stage I)	
Balanced submerged filling	0.3
Underground tank breathing and emptying	1.0
Vehicle refueling operations (Stage II)	
Displacement losses (uncontrolled) Displacement losses (controlled)	Use MOBILE5 to estimate a gram per gallon emission factor, then multiply by gasoline sales. Need to input an estimate of Stage II system efficiency where applicable.
Spillage	0.7

	Original 1996 PA Estimates VOC (tpd)	Revised 1996 Estimates VOC (tpd)
Architectural Surface Coating	100	104.5
Auto Refinishing	54	52.8
Degreasing	78	96.0
Consumer Products	104	129.5
Gasoline Marketing		
Stage I	0.5	2.0
Stage II	62	51.0
	398.5	435.8

	Original 1996 PA Estimates VOC (tpd)	Revised 1996 Estimates VOC (tpd)	Original 1996 PA Estimates NO_x (tpd)	Revised 1996 Estimates NO_x (tpd)
Off-Highway				
Non-road Gasoline	168.5	424.5	41.1	17.4
Non-road Diesel	19.7	56.1	132.9	355.9
Aircraft	15.5	28.0	6.2	27.0
Marine Vessels	0.0	1.0	0.0	16.0
Railroads	1.9	7.0	44.3	61.0
Non-road Other	0.0	0.0	0.0	38.3
	205.6	516.6	224.5	515.6

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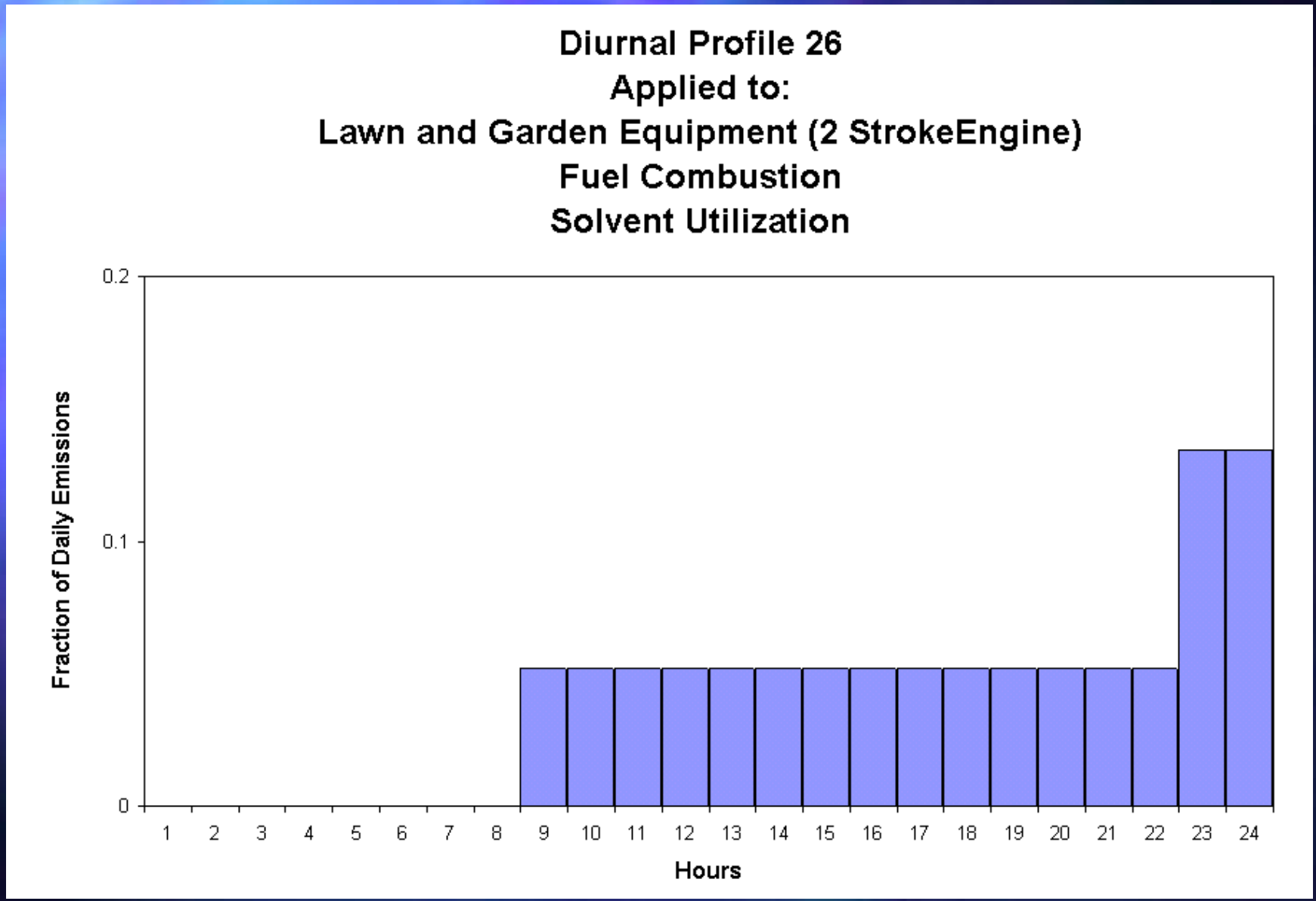
TEMPORAL PROFILING	SURROGATE MOTHERS	ENDANGERED SPECIES PROFILES	I KNOW WHAT YOU DID LAST OZONE SEASON	TWO BRICKS SHY OF A BASELOAD	THROUGH THE HOUR GLASS
$200	$200	$200	$200	$200	$200
$400	$400	$400	$400	$400	$400
$600	$600	$600	$600	$600	$600
$800	$800	$800	$800	$800	$800
$1000	$1000	$1000	$1000	$1000	$1000

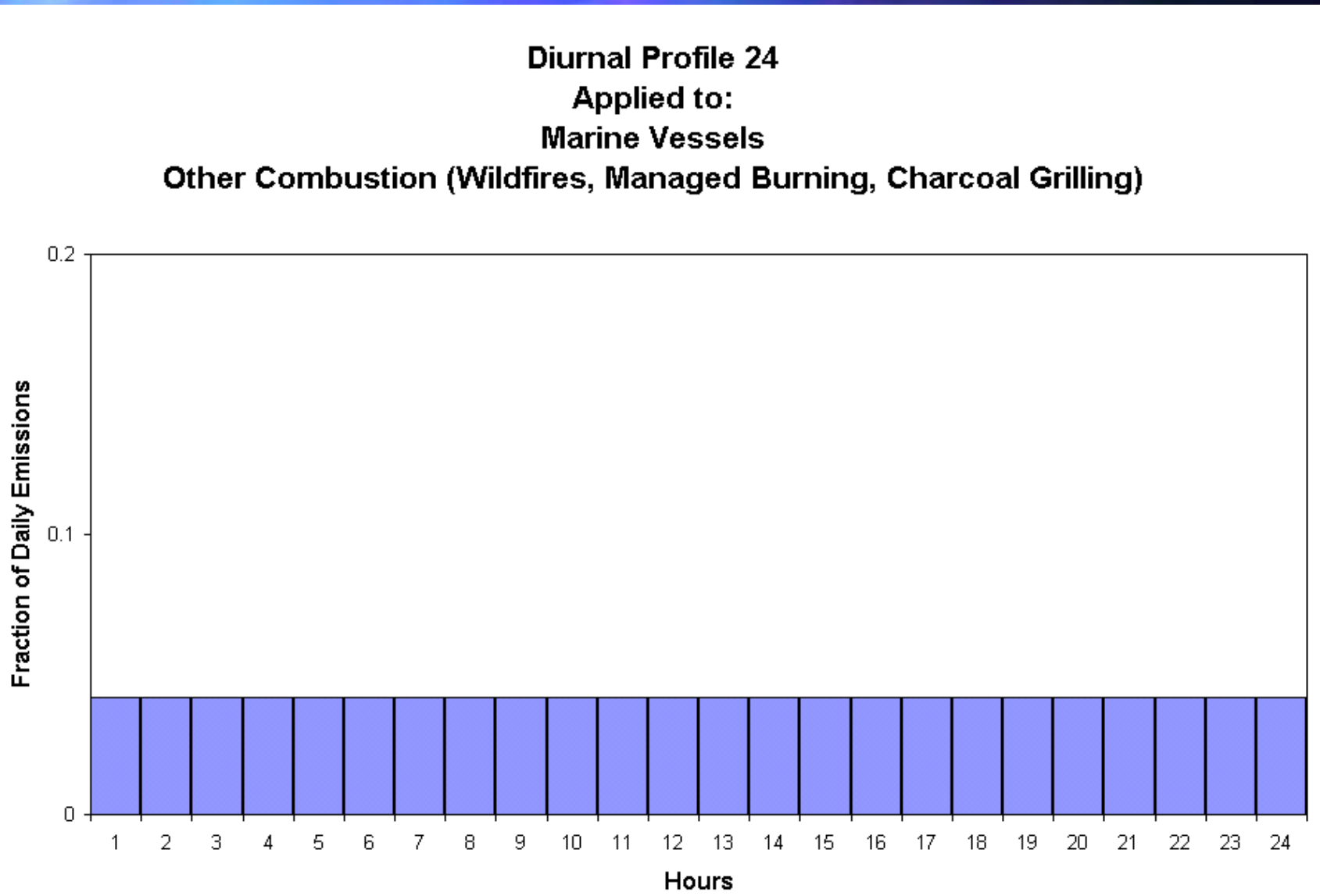
Speciation Profiles

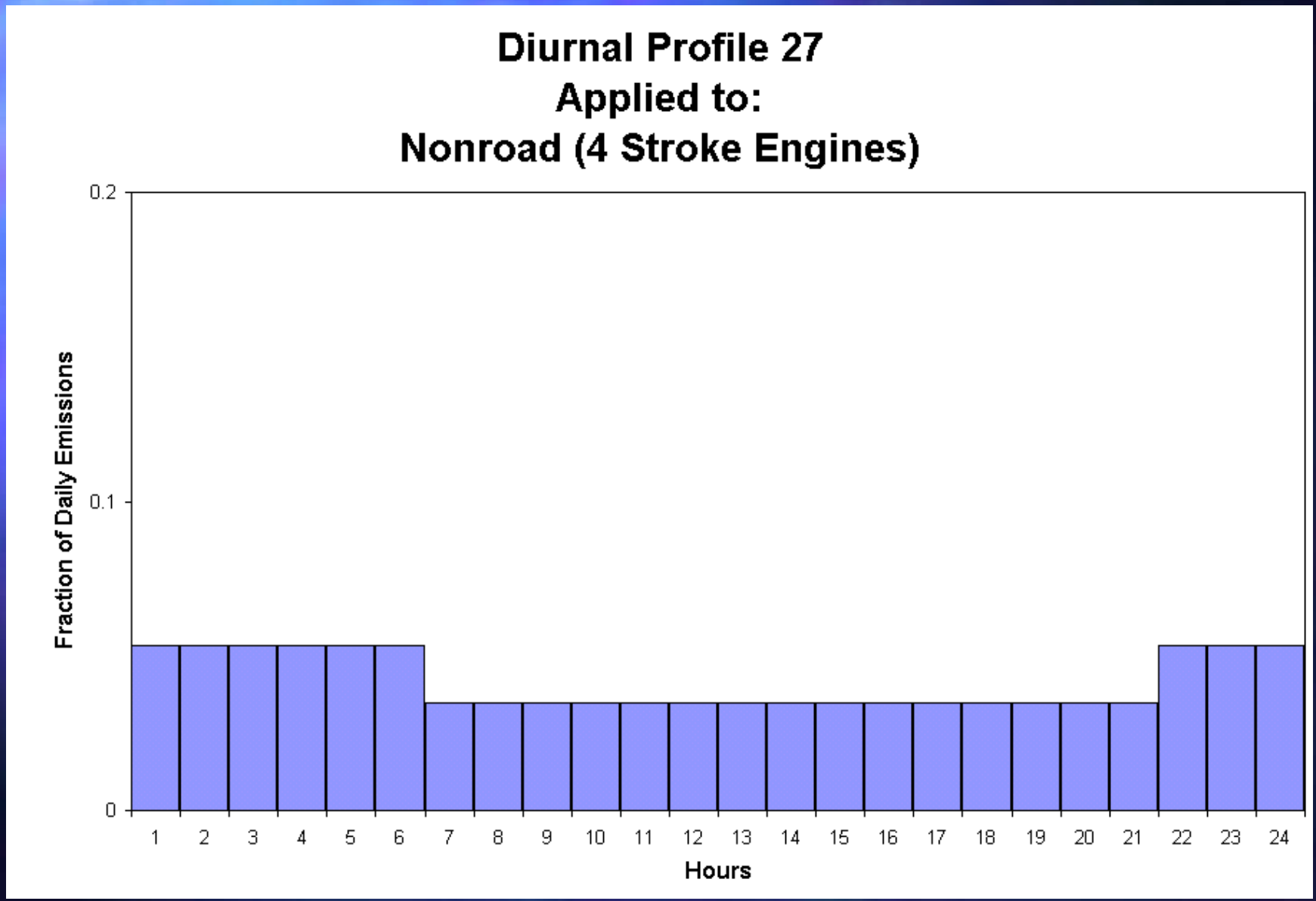
- Speciate 3.0 profiles for the key area source categories based on mid-to-late 1980s data
- New recommended profiles are from California ARB
- Examples:
  - Consumer Solvents
    - ARB data indicate a much more reactive mixture
    - Includes olefins and aromatics
    - Lower unreactive fraction
  - AIM Coatings
    - Used 3 ARB profiles: Solvent-based
      Water-based
      Clean-up
    - Result is a less reactive mixture (lower toluene content)

Temporal Profiling

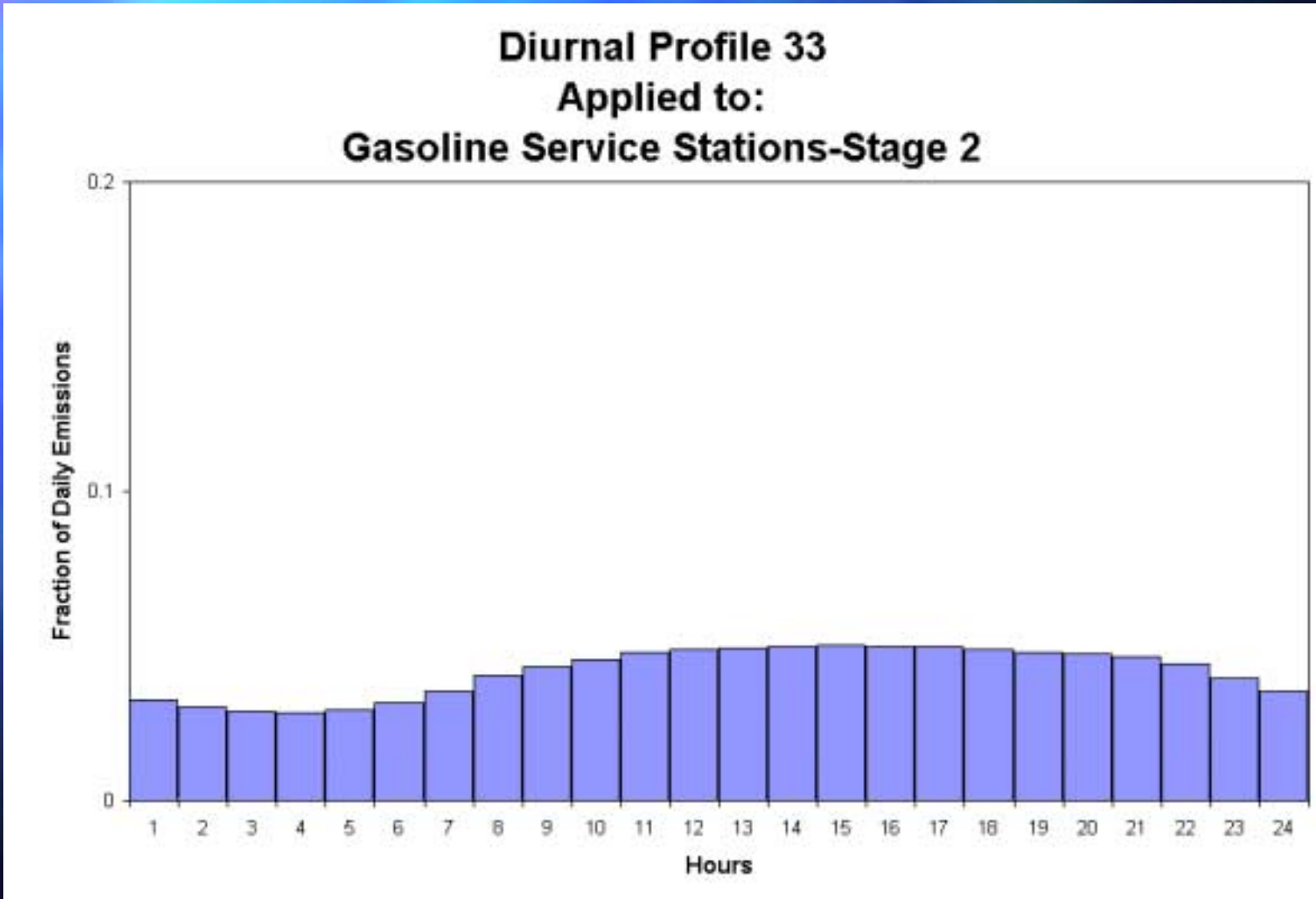
- Stakeholder modeling assigned all area source categories to one of three profiles

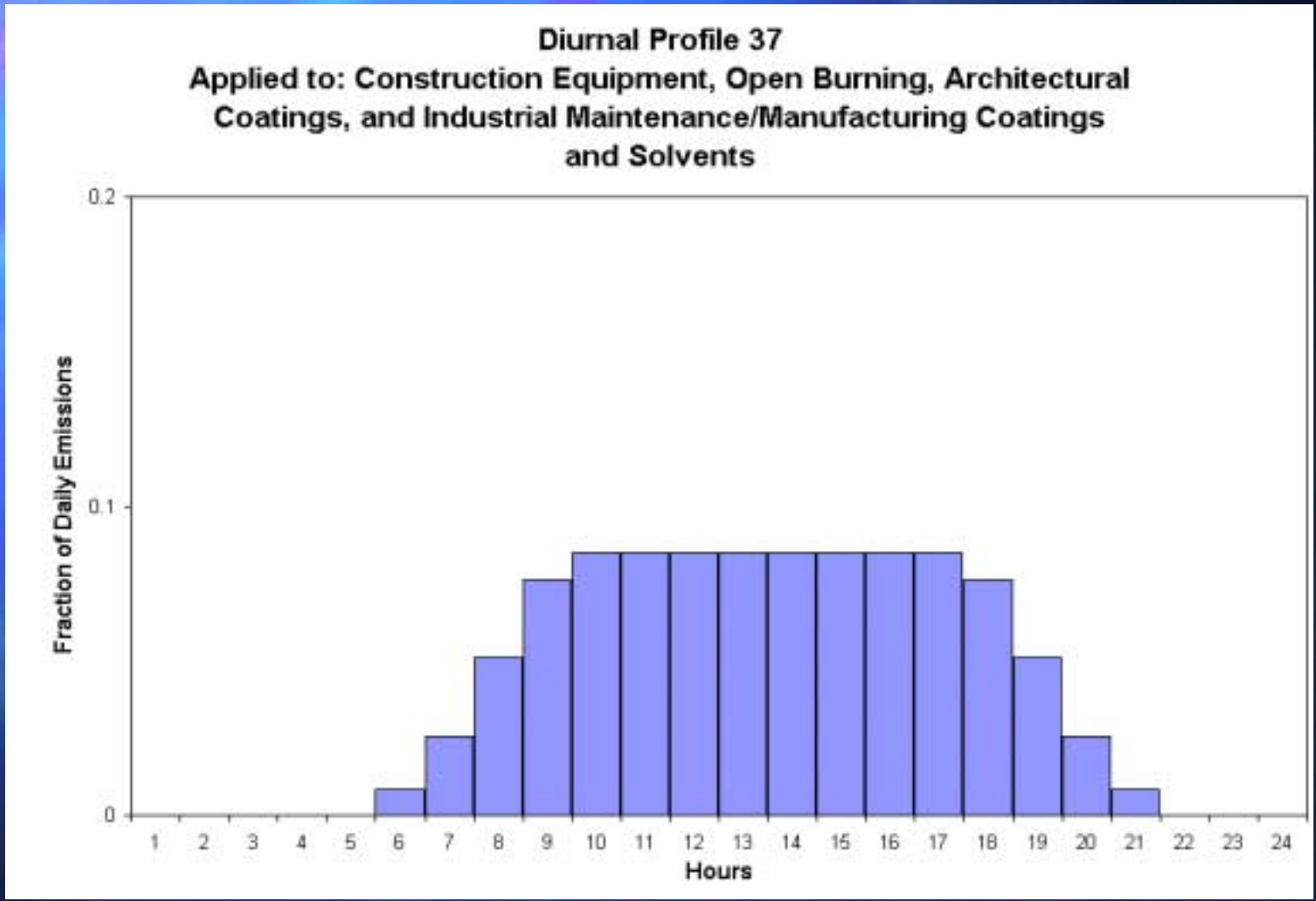

Diurnal Profile 26
Applied to:
Lawn and Garden Equipment (2 StrokeEngine)
Fuel Combustion
Solvent Utilization
Fraction of Daily Emissions
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hours

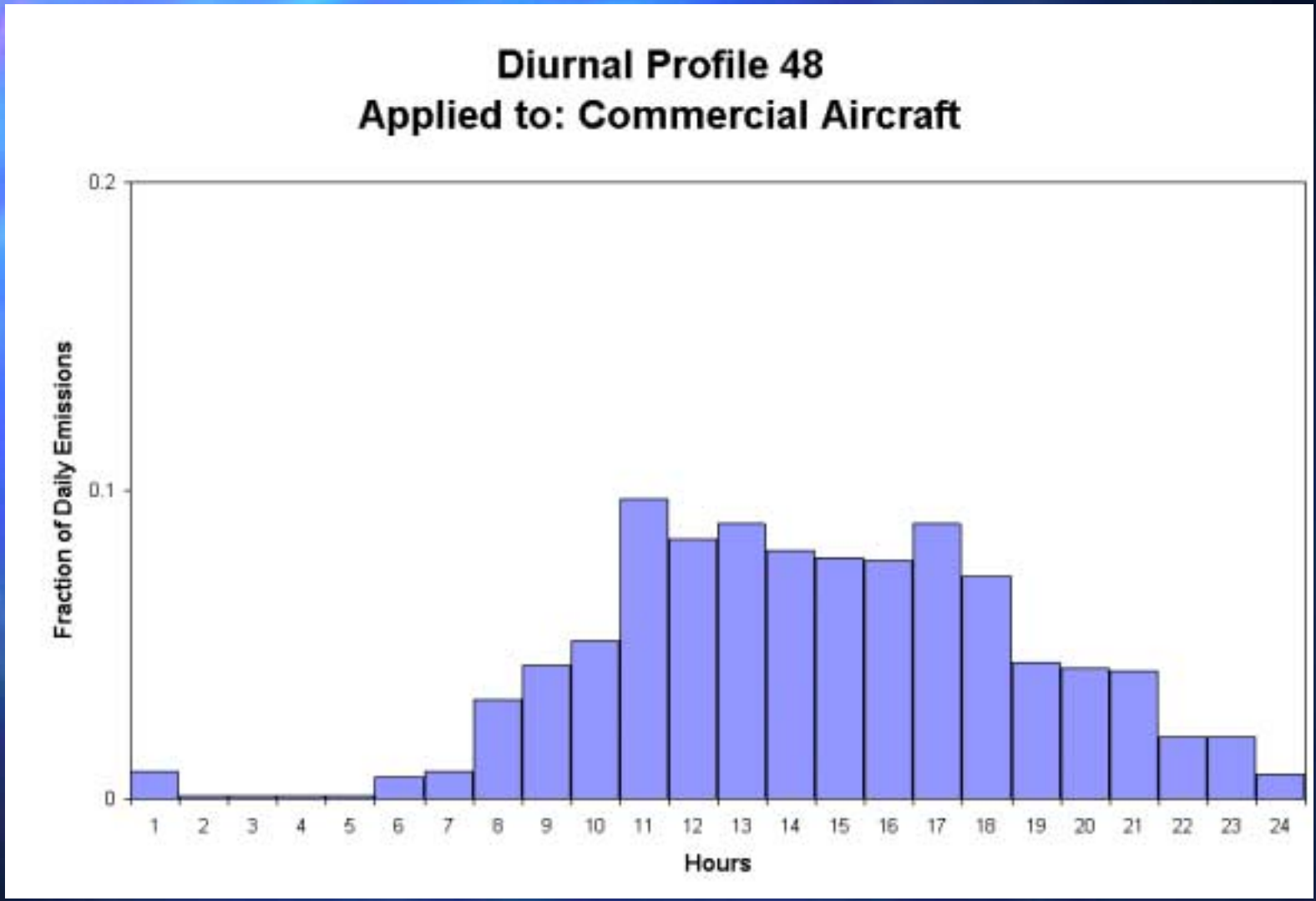

Diurnal Profile 24
Applied to:
Marine Vessels
Other Combustion (Wildfires, Managed Burning, Charcoal Grilling)
Fraction of Daily Emissions
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hours

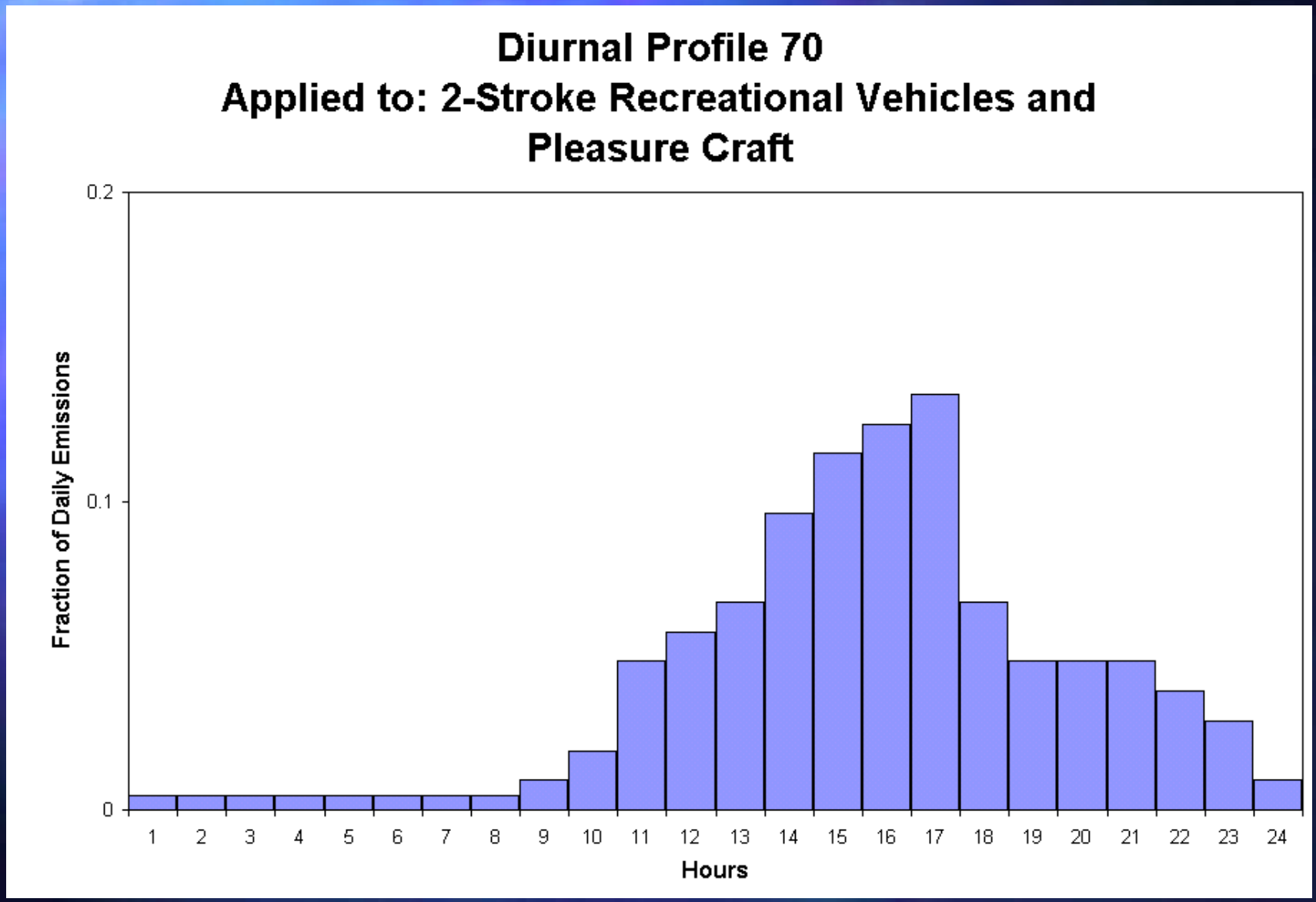

Diurnal Profile 27
Applied to:
Nonroad (4 Stroke Engines)
Fraction of Daily Emissions
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hours

Recent Improvements in Temporal Profiles




Diurnal Profile 37
Applied to: Construction Equipment, Open Burning, Architectural Coatings, and Industrial Maintenance/Manufacturing Coatings and Solvents
Fraction of Daily Emissions
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours


Diurnal Profile 48
Applied to: Commercial Aircraft
Fraction of Daily Emissions
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours


Diurnal Profile 70
Applied to: 2-Stroke Recreational Vehicles and Pleasure Craft
Fraction of Daily Emissions
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours

Electricity Generating Units

- Hourly profile assignments in EMS-95
  - Hourly profile code
  - No code provided - equal hourly emissions assumed
- Daily profiles
  - Priority 1. Day-of-week profile code
  - Priority 2. Reported hours/yr, days/yr, weeks/yr
  - Priority 3. Default profile

Improvements

1. Assign LADCO-developed profiles for EGUs (7 choices)

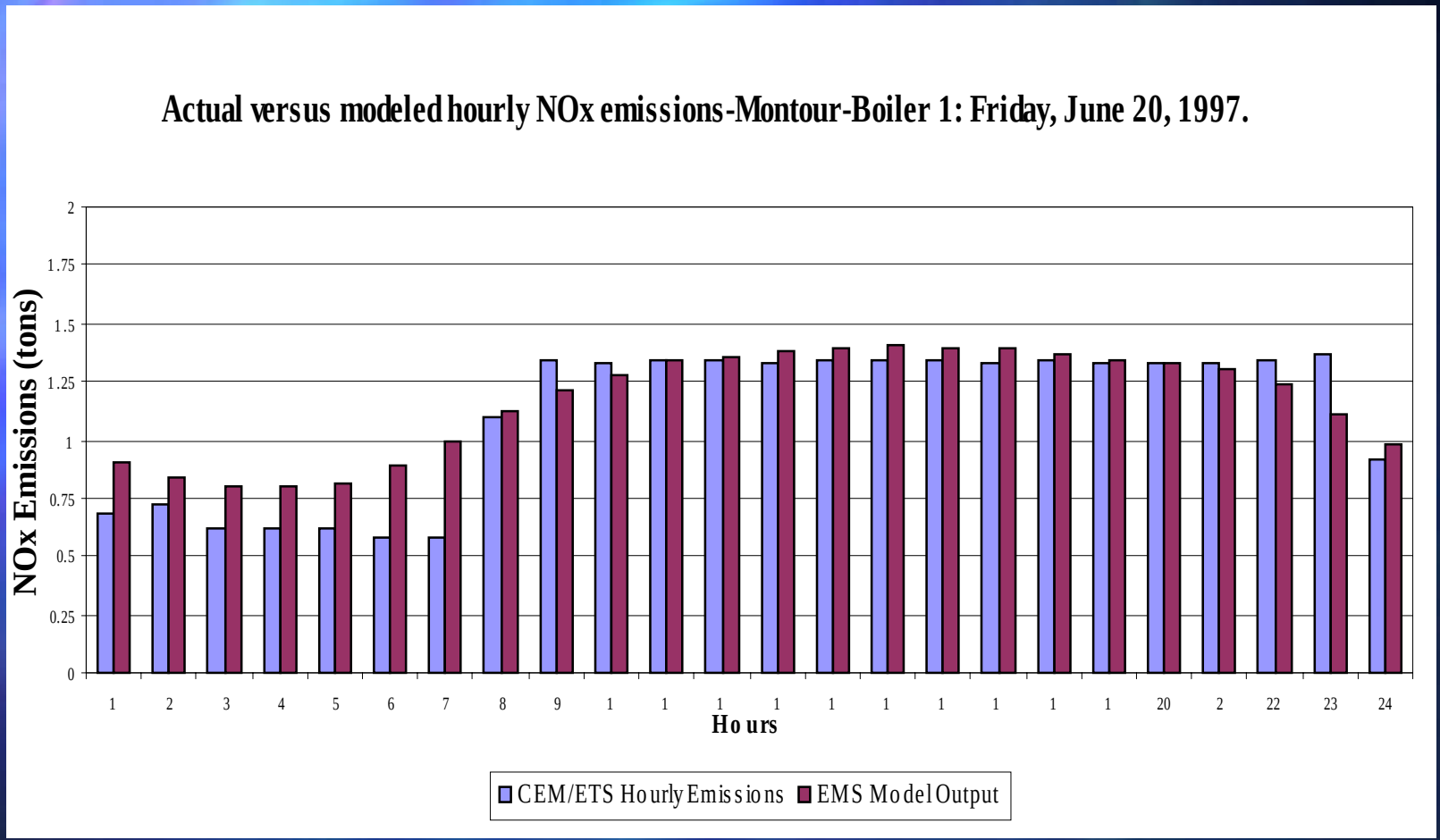
   See www.ladco.org/emis/temporal

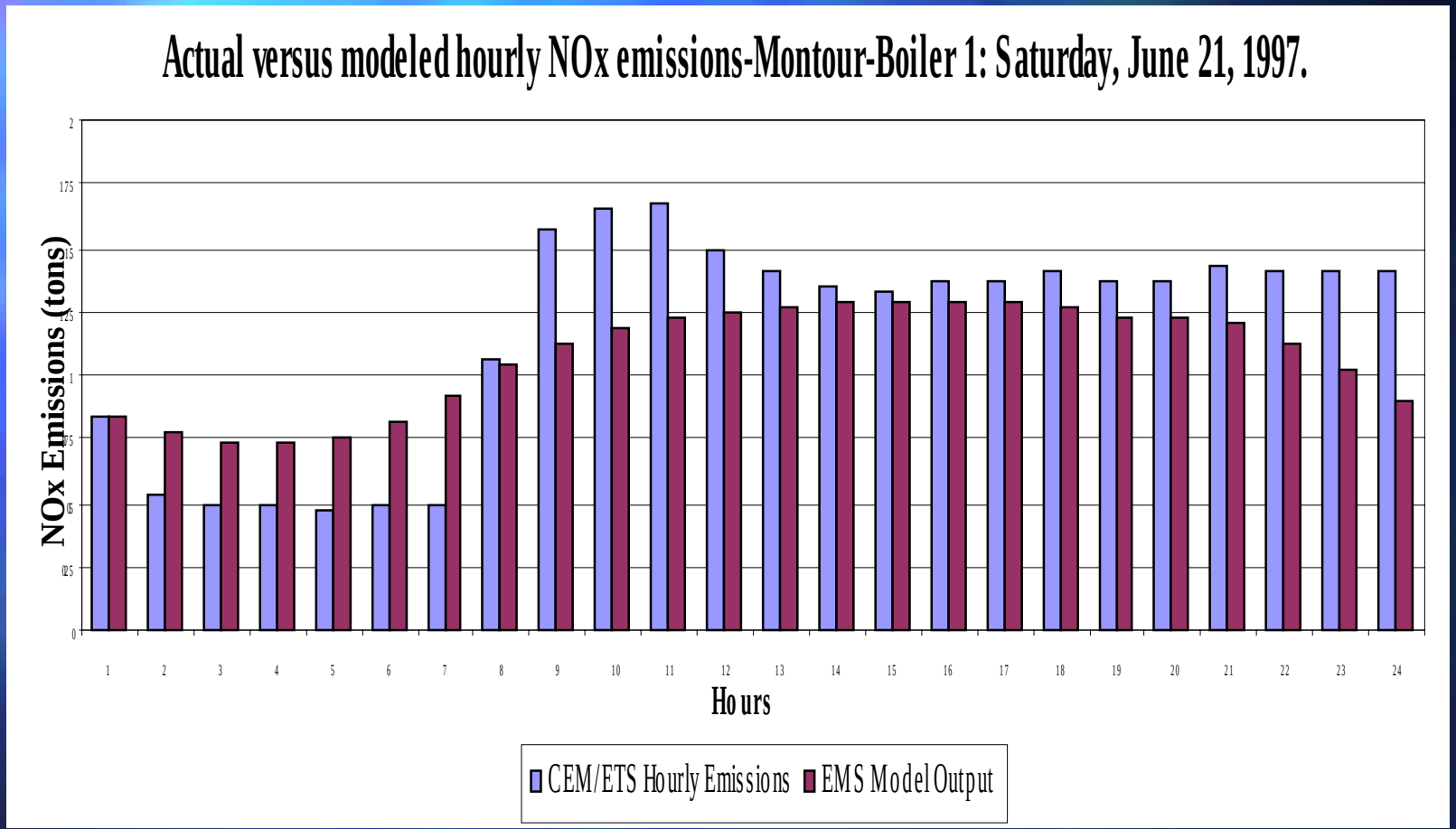
2. Or use ETS/CEM data - hourly NO_x emissions by unit for the historical episode period

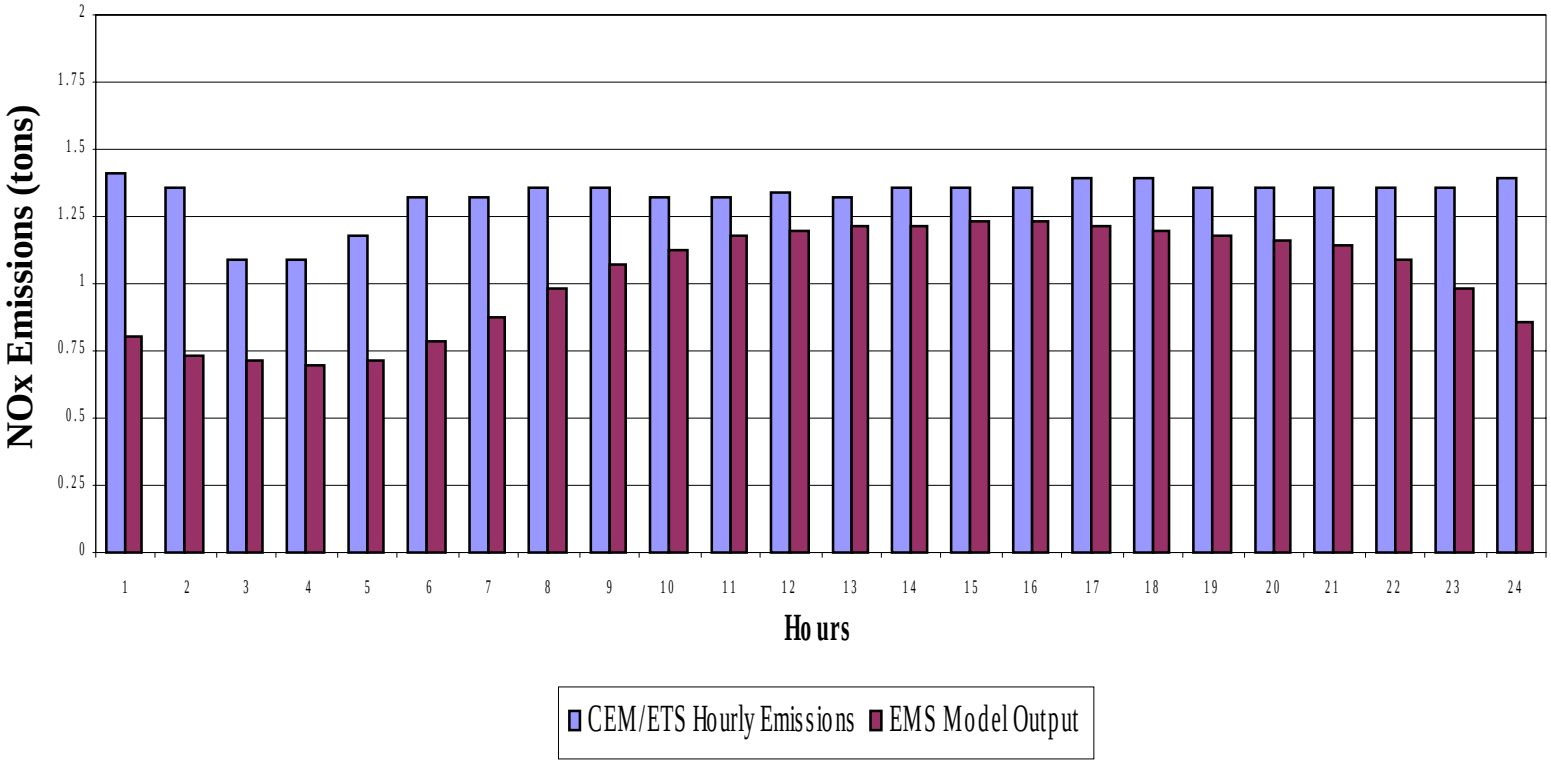
Analyses Performed for the 7 Largest NO_x Emitting EGUs in Pennsylvania

Examined June 18-August 12, 1997 emissions

1. Diurnal profile of actual hourly percentage of NO_x emissions
   - use to match units with LADCO profiles
2. Weekday/Saturday/Sunday emissions
   - differences can be distinguished using 2 profiles
3. Emissions as a function of temperature
   - No correlation found for these baseline units
4. EMS-95 outputs versus actual hourly emissions


Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Friday, June 20, 1997.
NOx Emissions (tons)
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1 1 1 1 20 2 22 23 24
Hours
CEM/ETS Hourly Emissions
EMS Model Output


Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Saturday, June 21, 1997.
NOx Emissions (tons)
2
175
15
125
1
075
05
025
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
Hours
CEM/ETS Hourly Emissions
EMS Model Output


Actual versus modeled hourly NOx emissions-Montour-Boiler 1: Sunday, June 22, 1997
NOx Emissions (tons)
2
1.75
1.5
1.25
1
0.75
0.5
0.25
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hours
CEM/ETS Hourly Emissions
EMS Model Output

Conclusions

- States think EIIP suggested area source surveys are too expensive
- Alternatives
  - Population-based factors
  - Employment-based factors
  - Pennsylvania has chosen population-based for major VOC area source categories
- Recommendations
  - States within each region adopt common/comparable methods
  - RPOs - cooperatively fund area source surveys

- Speciation Profiles
  - New profiles are available
  - Reflect species in modern solvents
  - Important to use in future year modeling
- Temporal Profiles
  - Better profiles are available than have been used in some recent modeling

- Major Point Sources
  - Consider using hourly NO_x emissions from CEMs for large EGUs (base period only)
  - Or, match EGU units with hourly and weekday/Sat/Sun profiles

- Next Steps
  - Before and after for Lancaster County emissions
  - New ozone simulations using revised Statewide emissions, speciation, temporal profiles
- Results will be posted on: www.pechan.com/products/reports

PAINTS, COATINGS, AND FINISHES

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WHICH AREA IN THE NORTHEAST OZONE TRANSPORT REGION HAS THE LOWEST VOC EMISSION FACTOR FOR AIM COATINGS?