Information and discussion process on Hydro-Québec’s Transmission System Planning

Groupe - TransÉnergie et équipement

June 4, 2021

Agenda

9 a.m. : Welcoming remarks

9:15 a.m. : Profile of projects registered in OASIS

9:45 a.m. : Montérégie development plan

10:30 a.m. : New technologies : Parent batteries and DERMS

11:30 a.m. : Discussion

12 p.m. : End of meeting

225T Hertel–New York (CHPE) 1,250 MW, commissioning 2025

1. AC-to-DC converter at the 735-kV Hertel substation
2. 49-km 400-kV DC line

226T Montérégie–Vermont (NECPL) 1,000 MW, commissioning 2027

1. AC-to-DC converter at the 735-kV Montérégie substation
2. 100-km 320-kV DC line

227R 380-MW capacity increase at Manic-3, commissioning 2028–2033

1. Replacement of the station's 6 generating units with higher-capacity units

228R 94-MW capacity increase Outardes-2, commissioning 2025–2027

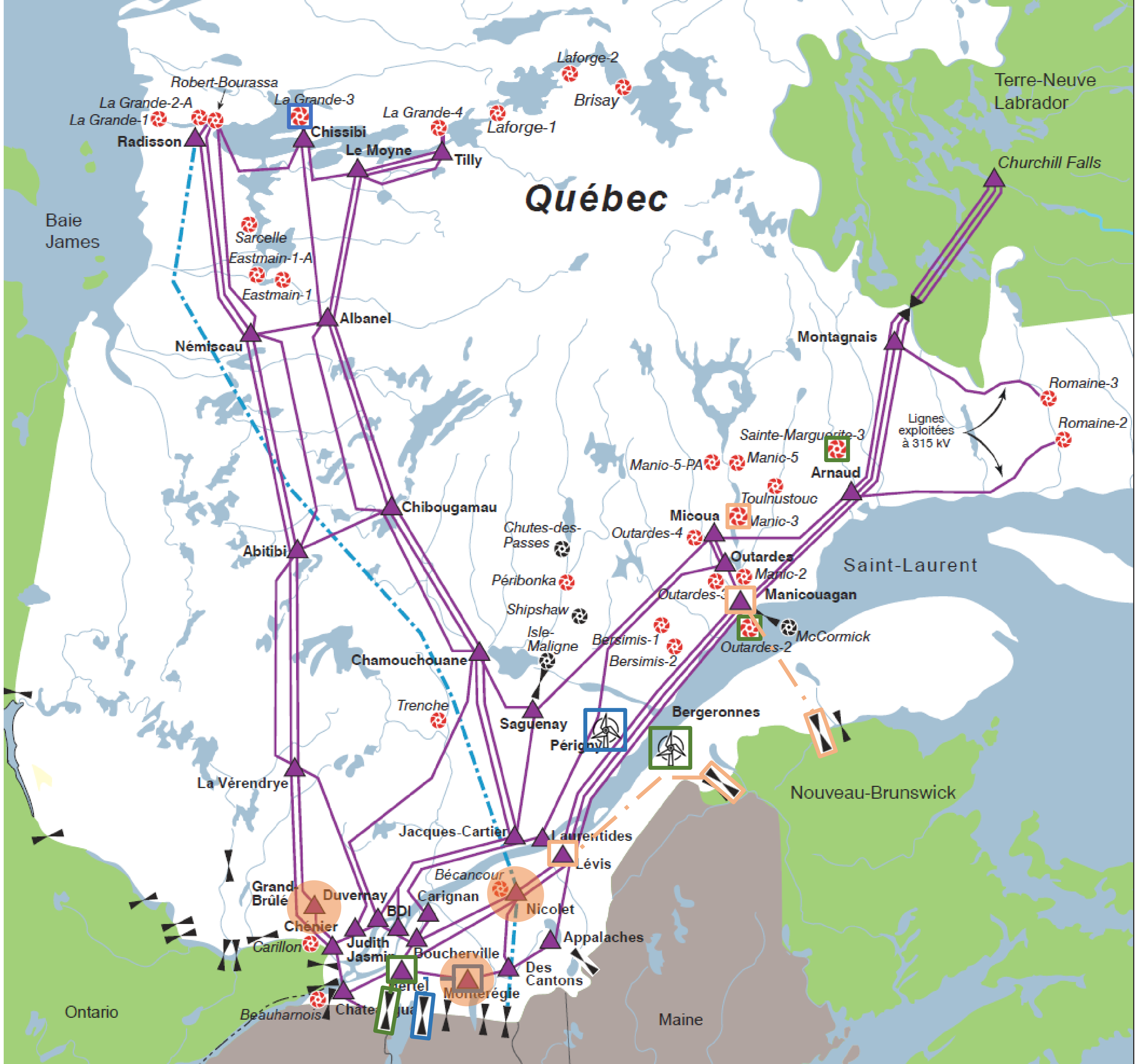
1. Replacement of the station's 3 generating units with higher-capacity units

229R Modifications to the Grande-3 generators, commissioning 2026–2037

1. Replacement of the station's 12 generating units with units having different inertia

230R Modifications to the generators and 223-MW capacity increase at La Grande-3, commissioning 2026–2037

1. Replacement of the station's 12 generating units with units having different inertia and higher capacity



231R 440-MW capacity increase at Sainte-Marguerite-3, commissioning 2031

1. Addition of a 3rd generating unit

233R Seigneurie de Beaupré 7, 8 and 9 800-MW wind farms, commissioning 2024

1. Connection of 3 new wind farms (400, 300 and 100 MW, respectively)

234T Quebec–New Brunswick +1,150 MW, commissioning 2025

1. Connection scenario still under study
2. AC-to-DC converter at Manicouagan or Lévis substation
3. 320- or 400-kV DC line

236R Bas-St-Laurent 400-MW wind farm, commissioning 2024

1. Connection of a new 400-MW wind farm

238R Bas-St-Laurent-2 600-MW wind farm, commissioning 2025

1. Connection of a new 400-MW wind farm

239R Seigneurie de Beaupré-X2 200-MW wind farm, commissioning 2024

1. Connection of a new 200-MW wind farm

Main assumptions for power plants'connection in exploratory studies

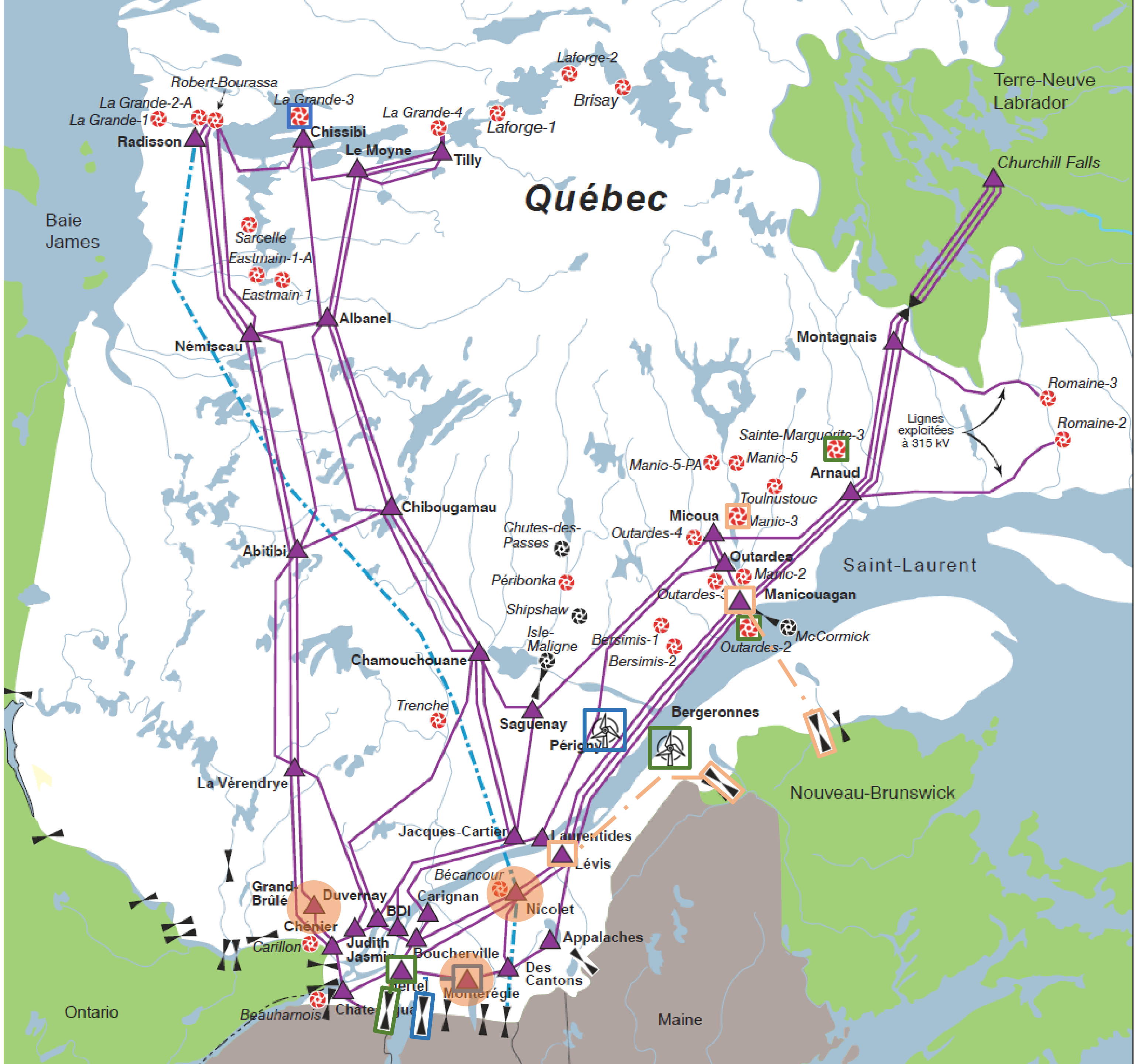
1. Technical requirements for the connection of generating stations to the Hydro-Québec transmission system
2. OASIS list
3. Maximum real power output will be Integrated (100% installed capacity)
4. If available, provide an online diagram of the high voltage side of the private producer substation.

Main transmission system reinforcements

1. Impact of the power plant location compared to Montreal loop
2. Requested installed capacity or maximum real power output

Short circuit ratio in regional areas

1. Reminder on Icc Ratio calculations
2. Wind Turbine Technology



Open Planning

Evolution Plan: Montérégie – Saint-Césaire

Gervais Bergeron, P.Eng.
Planification des réseaux régionaux Sud-Ouest
Direction Planification
Groupe TransÉnergie et équipement
2021-06-03 and 2021-06-04

Presentation overview

– Study area
– Growth and long-term operability of the regional system
– Growth of the satellite substations
– Selected solution
– Costs and schedule

Study area


Baie James
Québec
Fleuve Saint-Laurent
Golfe du Saint-Laurent
City of Québec
Montréal
Ile-du-Prince-Edouard
0 183,5 367
kilomètres
Echelle de la carte: 1:13 890 198

Study area

1 strategic substation

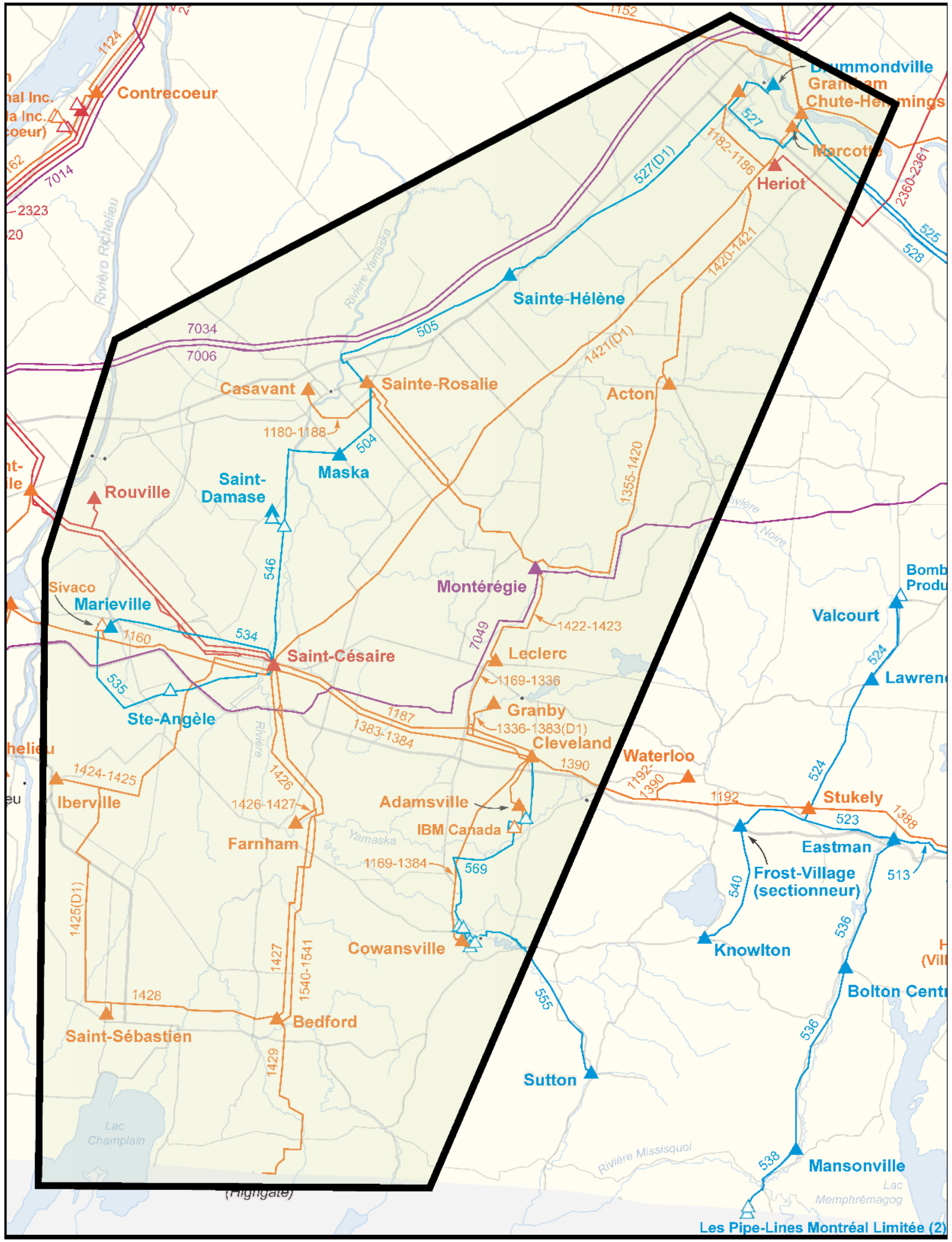
3 source substations

16 satellite substations

4 customer substations

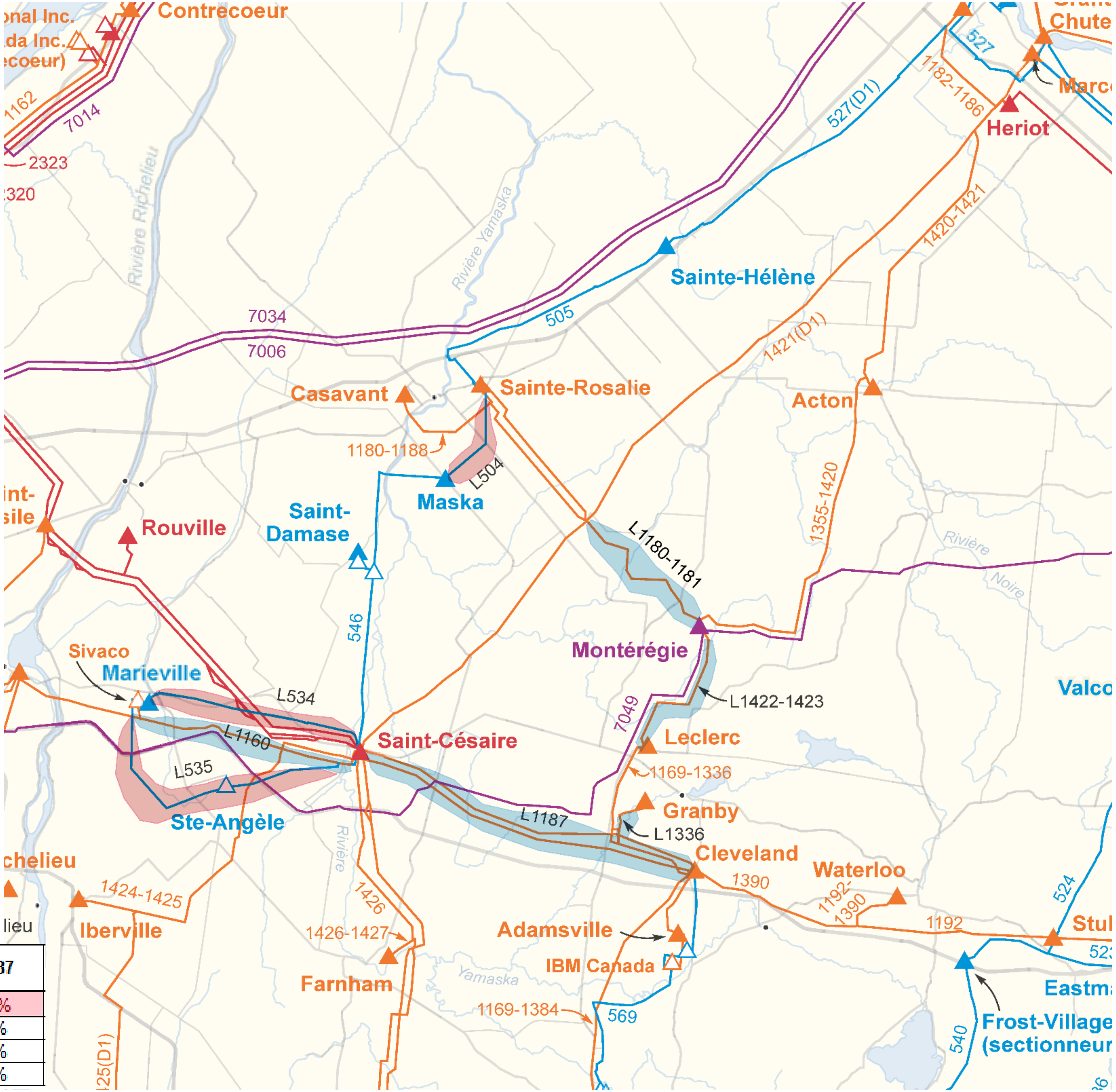
31 high-voltage lines

1 interconnection



Regional system

- Winter/summer overloads
- Long-term operability
  49 kV



Pointe d'été	L504	L534	L535
2020	105%	103%	101%
2025	106%	102%	101%
2034	106%	103%	102%

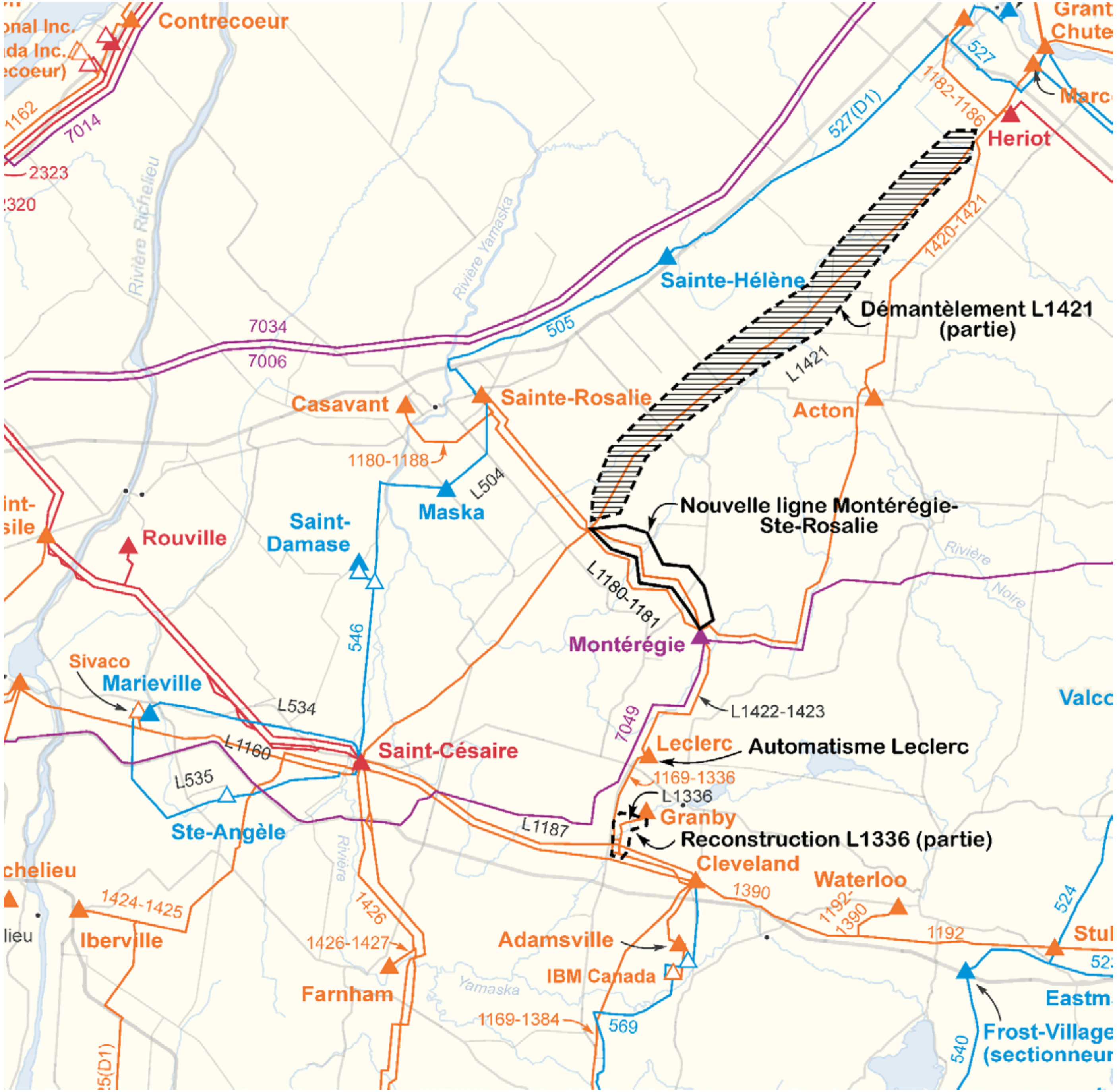
Pointe hiver	L1422	L1423	L1336	L1180	L1181	L1160	L1187
20-21	117%	117%	101%[1]	102%	102%	88%	110%
24-25	118%	118%	106%	105%	104%	93%	89%
32-33	123%	123%	112%	109%	109%	100%	96%
33-34	124%	124%	113%	109%	109%	101%	96%

Growth of the satellite substations

Postes	CLT	Prévision de la demande en MVA (septembre 2020)														
	(MVA)	20-21	21-22	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	30-31	31-32	32-33	33-34	34-35
Zone Nord																
Acton 120-25	**126**	95,2	95,9	96,4	97,0	97,6	98,1	98,7	99,3	99,8	100,4	100,9	101,5	102,0	102,5	103,0
Casavant 120-25	**189**	189,1	193,6	195,3	197,1	198,8	200,5	202,2	203,8	205,4	207,0	208,6	210,1	211,7	213,3	214,9
Maska 49-25	**28**	18,2	18,4	18,7	19,0	19,2	19,5	19,8	20,1	20,4	20,7	21,0	21,2	21,5	21,8	22,1
Sainte-Hélène 49-25	**20**	18,3	18,6	18,8	19,0	19,2	19,4	19,6	19,8	20,0	20,1	20,3	20,5	20,7	20,8	21,0
Sainte-Rosalie 120-25	**65**	74,1	75,4	75,8	76,2	76,7	77,2	77,7	78,2	78,7	79,3	79,8	80,4	81,0	81,5	82,1
Sainte-Rosalie 49-25	**31**	21,7	21,9	22,1	22,3	22,6	22,8	23,0	23,2	23,5	23,7	23,9	24,2	24,4	24,6	24,8
Total de la zone Nord	**459**	**417**	**424**	**427**	**431**	**434**	**438**	**441**	**444**	**448**	**451**	**455**	**458**	**461**	**465**	**468**
Zone Sud																
Bedford 120-25	**30**	30,5	28,0	28,2	28,4	28,6	28,8	29,0	29,2	29,4	29,5	29,7	29,9	30,0	30,2	30,3
Cowansville 120-25	**120**	101,3	105,5	106,9	108,2	109,6	110,9	112,2	113,5	114,9	116,1	117,4	118,6	119,7	120,9	122,1
Farnham 120-25	**64**	72,5	73,1	73,7	74,3	74,9	75,6	76,3	77,0	77,7	78,4	79,1	79,8	80,5	81,2	81,9
Iberville 120-25	**123**	97,0	98,1	99,0	100,0	101,0	102,0	102,9	103,9	104,9	105,8	106,8	107,7	108,7	109,6	110,6
Marieville 49-25	**29**	26,4	26,6	26,8	27,0	27,2	27,4	27,6	27,8	28,0	28,3	28,5	28,8	29,0	29,3	29,5
Saint-Césaire 120-25	**65**	58,6	59,1	59,5	59,9	60,3	60,8	61,2	61,6	62,0	62,5	62,9	63,3	63,7	64,2	64,6
Saint-Sébastien 120-25	**62**	59,1	59,6	60,0	60,5	60,9	61,4	61,9	62,4	62,9	63,5	64,0	64,5	65,0	65,5	66,1
Total de la zone Sud	**493**	**445**	**450**	**454**	**458**	**463**	**467**	**471**	**475**	**480**	**484**	**488**	**492**	**497**	**501**	**505**
Zone Est																
Adamsville 120-25	**129**	89,3	104,3	115,5	117,6	119,7	121,7	123,7	125,8	127,8	129,8	131,8	133,6	135,5	137,3	139,1
Granby 120-25	**178**	174,2	156,6	158,4	160,3	162,3	164,3	166,2	168,2	170,2	172,2	174,1	175,9	177,8	179,6	181,5
Leclerc 120-25	**127**	113,6	121,3	122,1	119,1	120,0	120,9	121,8	122,7	123,7	124,6	125,5	126,4	127,3	128,2	129,1
Total de la zone Est	**434**	**377**	**382**	**396**	**397**	**402**	**407**	**412**	**417**	**422**	**427**	**431**	**436**	**441**	**445**	**450**
Grand total	**1386**	1239														1423
		89%														103%

Solution recommended

- New line: Montérégie – Sainte-Rosalie
- Reconstruction of L1336
- Leclerc automatic control



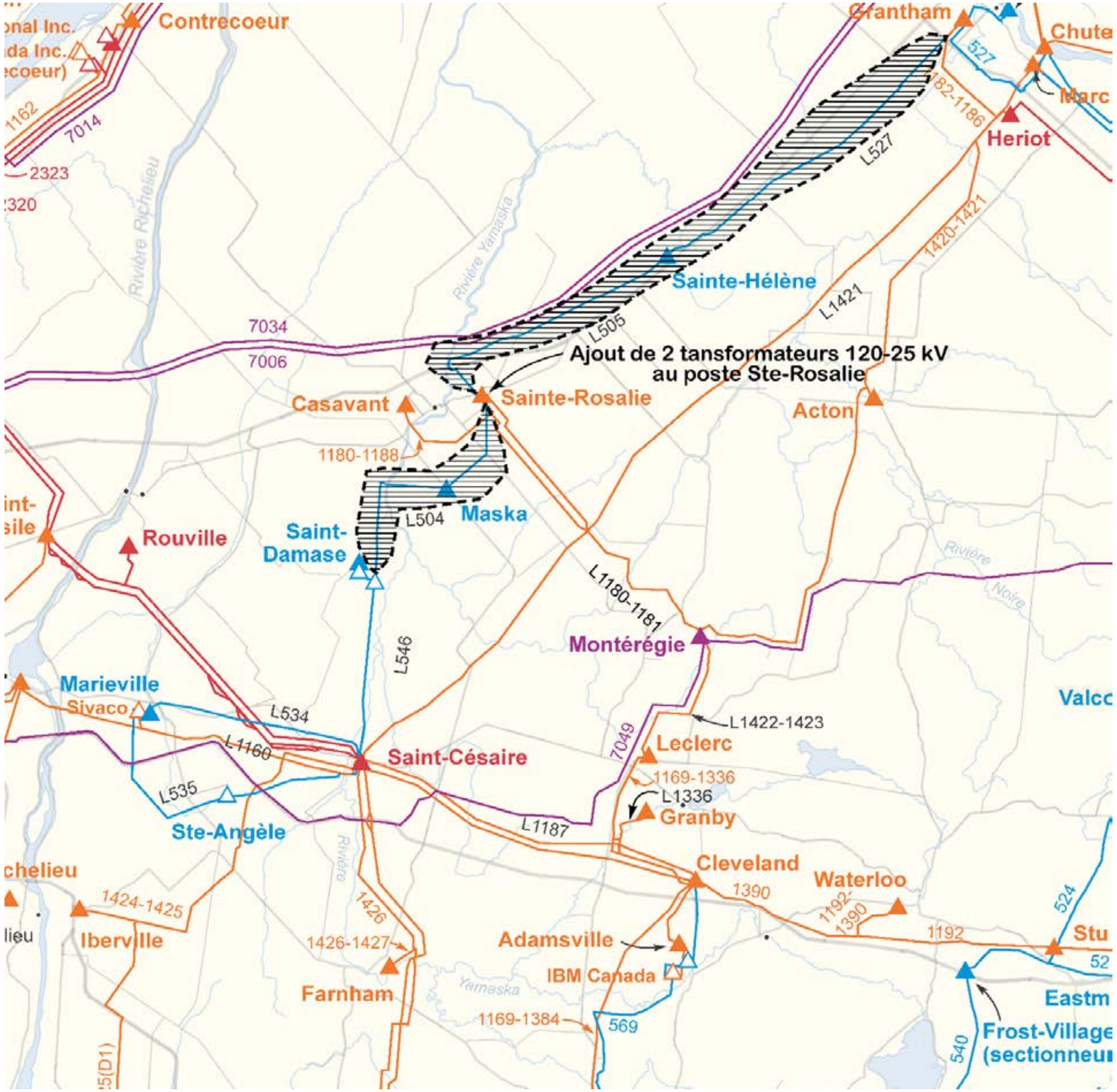
Conversion of 49 kV to 120 kV

Phase 1

– 3rd and 4th transformers in Sainte-Rosalie

– Dismantling Maska and Sainte-Hélène

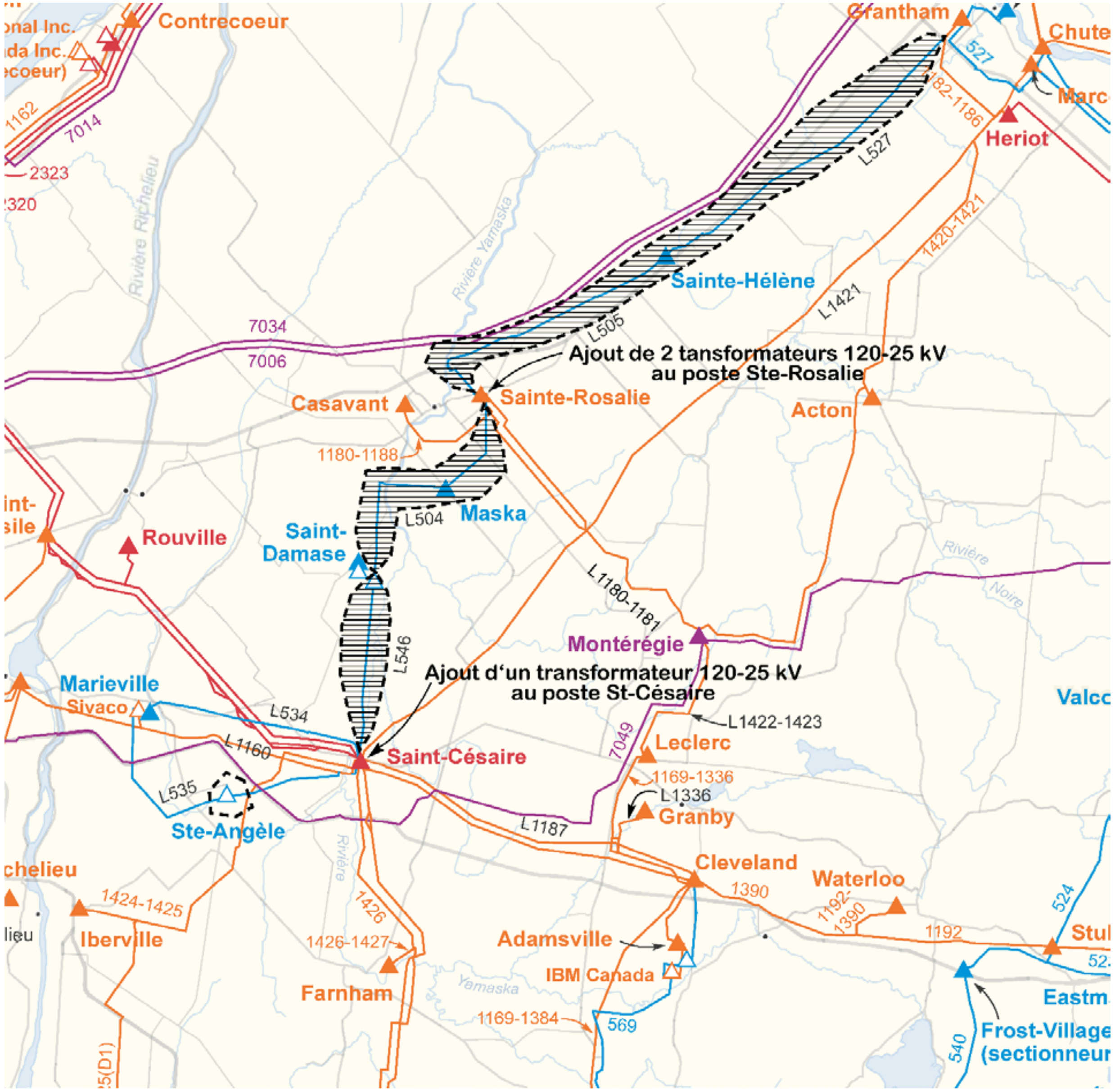
– Dismantling L504, L505, L527 (part) and L546 (part)



Conversion of 49 kV to 120 kV

Phase 2

- Adding a transformer in Saint-Césaire
- Conversion of the Coopérative d'électricité Saint-Jean-Baptiste de Rouville
- Dismantling of St-Damase and Ste-Angèle
- Dismantling of L546



Conversion of 49 kV to 120 kV

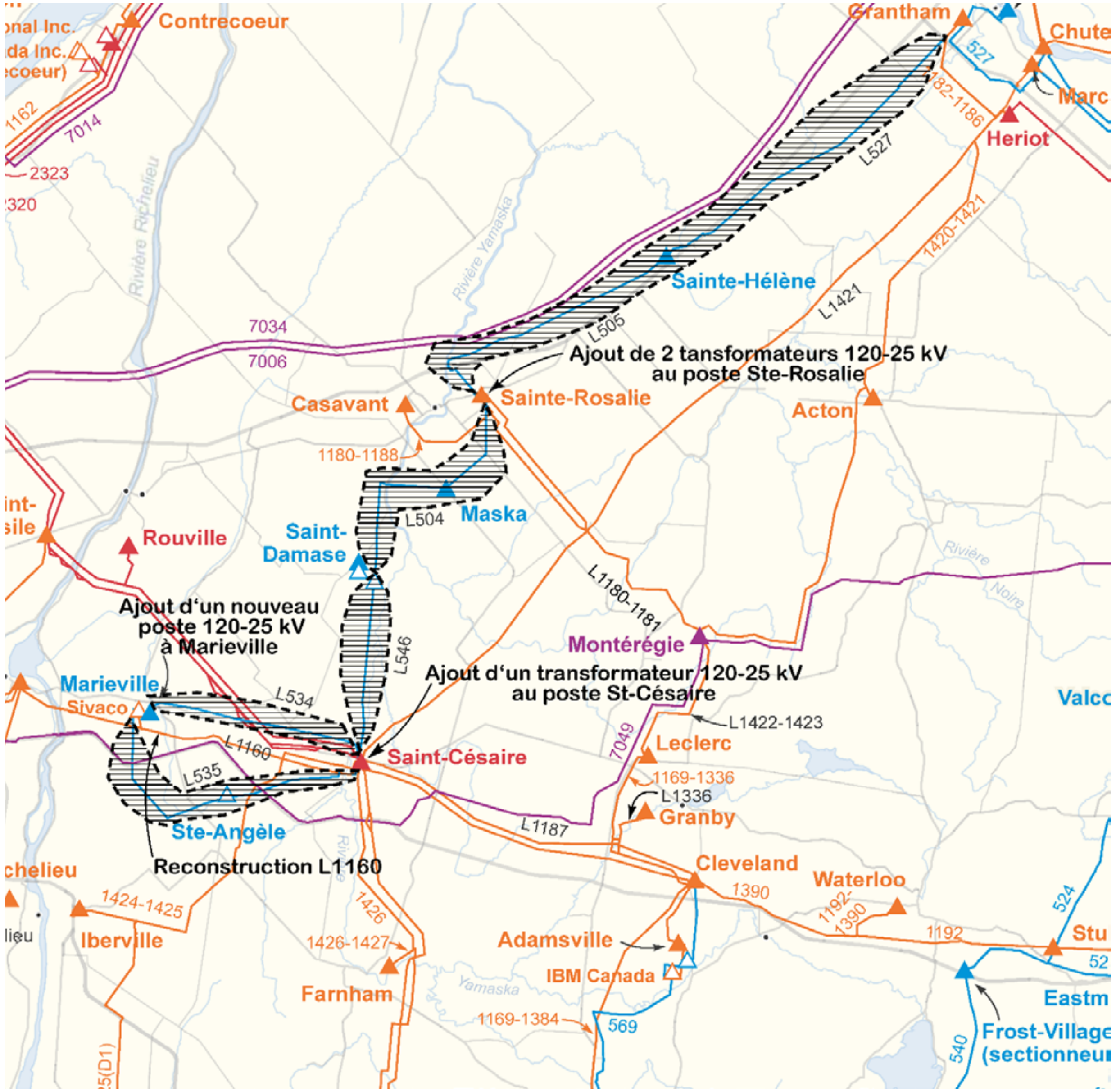
Phase 3

– New 120-25 kV substation in Marieville

– Reconstruction of L1160

– Dismantling of Marieville

– Dismantling of L534, L535



Costs and schedule

2021	Short Term	Medium Term	Long Term
Start of the projects	**Montérégie – Ste-Rosalie line Adding 2 transformers in Ste-Rosalie Dismantling of Maska, Ste-Hélène**	**Conversion of Coopérative d'électricité Saint-Jean-Baptiste de Rouville**	**New substation, Marieville**
Planned investment Transmission provider $ to carry out	**$190 million**	**$200 million (+$10 million)**	**$300 million (+$100 million)**

Hydro
Québec

Parent substation

Energy storage system

Open planning

Thierry Major-Cyr, Jr. P.Eng.
Planification des réseaux régionaux sud-ouest
Direction Planification
Groupe TransÉnergie et équipement

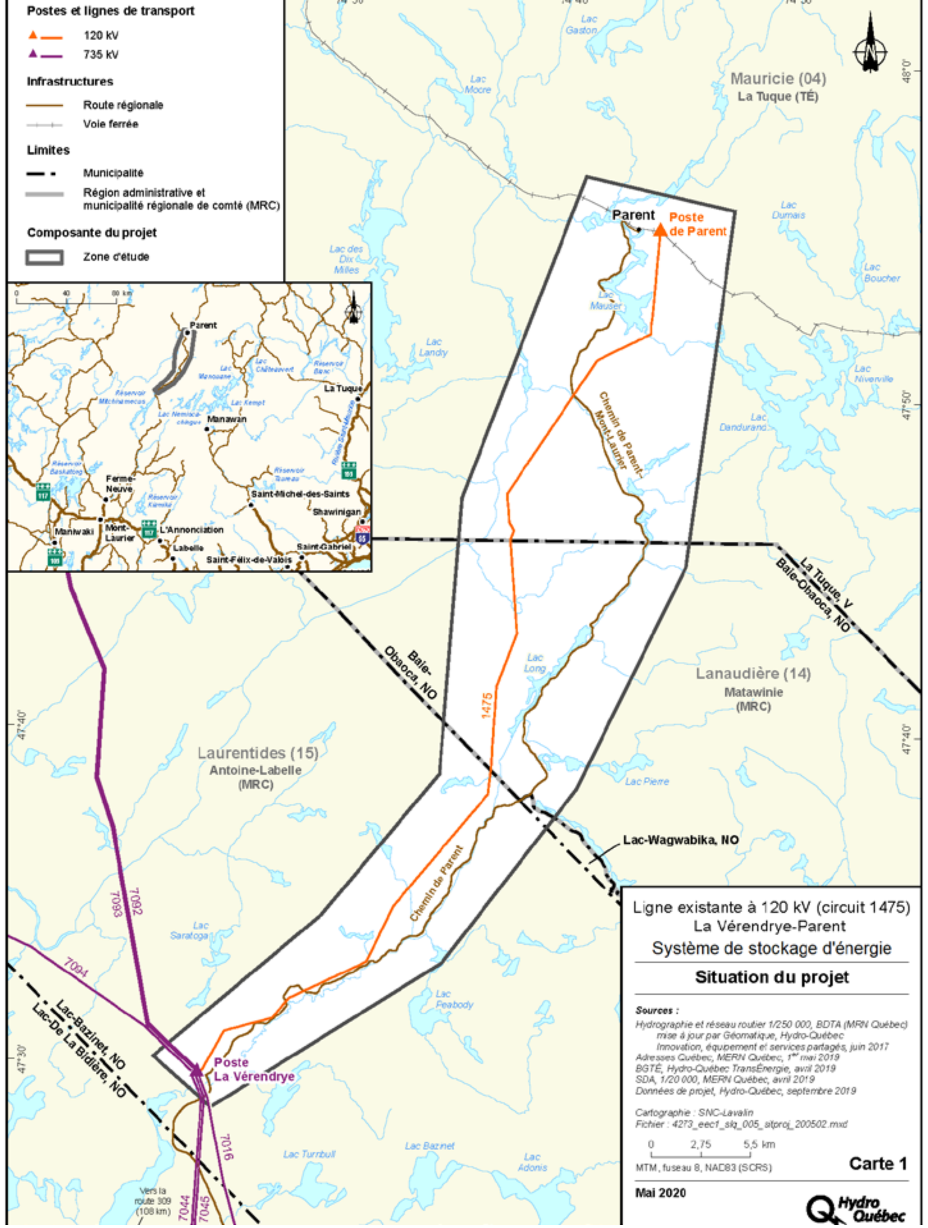
2021-06-03 and 2021-06-04

Parent substation – Energy storage system

Project background

Location of Parent

- Located in the Hautes-Laurentides in the greater La Tuque area
- Roughly 620 residents
- Radially energized by line 1475 from La Vérendrye substation
  - 58 km of rough terrain
  - 283 wooden H-frames
  - Extensively damaged line
    - Presence of woodpeckers
    - Maintenance is challenging given the difficulties access and leaving sites



Current substation

- Substation
  - Transit capacity limit of 15 MVA
  - Average growth of 0.1%
  - ~360 customers, including one large-power customer
- Operation limitations
  - No backup busbar
  - Upstream failure of the 25 kV breakers requires opening line 1475
  - No backup available in Distribution

Loads 2019	Average power (MW)		Peak	
	Summer	Winter	MW	MVA
L221	1.39	2.88	5.20	6.15
L222	0.21	0.63	1.02	1.02
Parent	1.60	3.51	5.98	6.62

Parent's history

- Reliability issue
  - Distributor's report from 2018
    - Reliability indices below regional and provincial averages
    - 75% of the interruptions are due to the transmission system
  - Several long outages between 2016 and 2018
  - 3 long outages (~36 hrs) in summer 2020
- In 2018, Hydro-Québec committed to investing in order to improve quality of service at the Parent substation.

Parent substation – Energy storage system

System needs

Projects for improving service quality

Refurbishment of line 1475

– Replacing 70% of the wooden H-frames with steel H-frames

1. Replacing multiple strategic H-frames in 2019 and 2020
2. Major work from November 2021 to April 2022
3. Replacement of remaining H-frames by maintenance crews between 2023 and 2035

Energy storage system (ESS) at the Parent substation

– Back-up through islanding during planned outages involving the transmission system

– Energizing Parent’s entire distribution system, except the large-power customer

– Independent enough to ensure one day of planned outages for work

Project objective

Improved service of service at Parent substation

Backup during outages and removals

- Potential for islanding with no interruption
- Potential for synchronization with no interruption

Sustainable energy supply during the work on line 1475

- 3,500 t of GHGs prevented
- Reduced noise and air pollution

Other spinoffs

Development of ESSs for the transmission system

Development of expertise within TransÉnergie et d'Équipement

- DER connection by power converter
- Island and ESS operation

Test bench for future applications

- Load-balancing
- System control by converters

ESS design

Energy requirements

- Duration of summer outages up to 36 hrs
- Removals lasting 16 hrs

Batteries with a capacity of 20 MWh

Power requirements

- Short-circuit power of at least 3 times the peak
- ESS fully recharged in less than 8 hrs

Converters with power of 4 MVA

Anticipated duration of power supply	Duration in summer (hrs)			Duration in winter (hrs)		
	Min.	Avg.	Max.	Min.	Avg.	Max.
Commissioning	86	92	98	22	32	44
End of life	62	67	73	16	23	32

Parent substation – Energy storage system

Project summary

General project

- Addition to Parent substation of a 4-MW / 20-MWH energy storage system by the subsidiary EVLO
- Addition of a remote-controlled clamp-on busbar between feeders L221 and L222
- Addition of an underground tie-in link to the ESS
- Addition of a removable control building for the ESS

EVLO Storage System Subsidiary

Characteristics

- Service life: 15 years / 7,000 cycles
- Depth of discharge
  - Maximum: 100%
  - Optimum: 98% to 10%
- Efficiency: 92%
- Features:
  - Islanding with no interruption
  - Black start
  - Ramped control
  - Voltage control (Volt-VAR)
  - Synchronization with the system
  - Frequency control
  - Smoothing of intermittent energy sources

https://www.evloenergy.com/en/products/evlo-500-1000/

Composition

- 20 1-MWh lithium-iron-phosphate (LiFePO4) 922-VDC battery modules
- 4 EPC Power Corporation 1-MVA 480-VAC converters
- 1 energy management system (EMS)
- 2 2-MVA 0.48-25-kV step-up transformers

Hydro
Québec

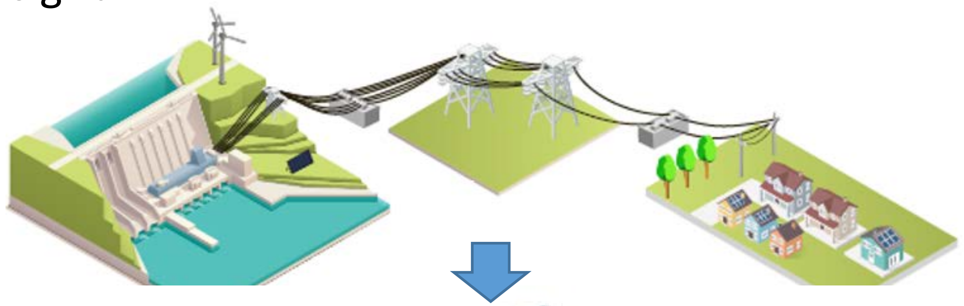
DERMS – Distributed Energy Resource Management System

DERMS – Distributed energy resource management system

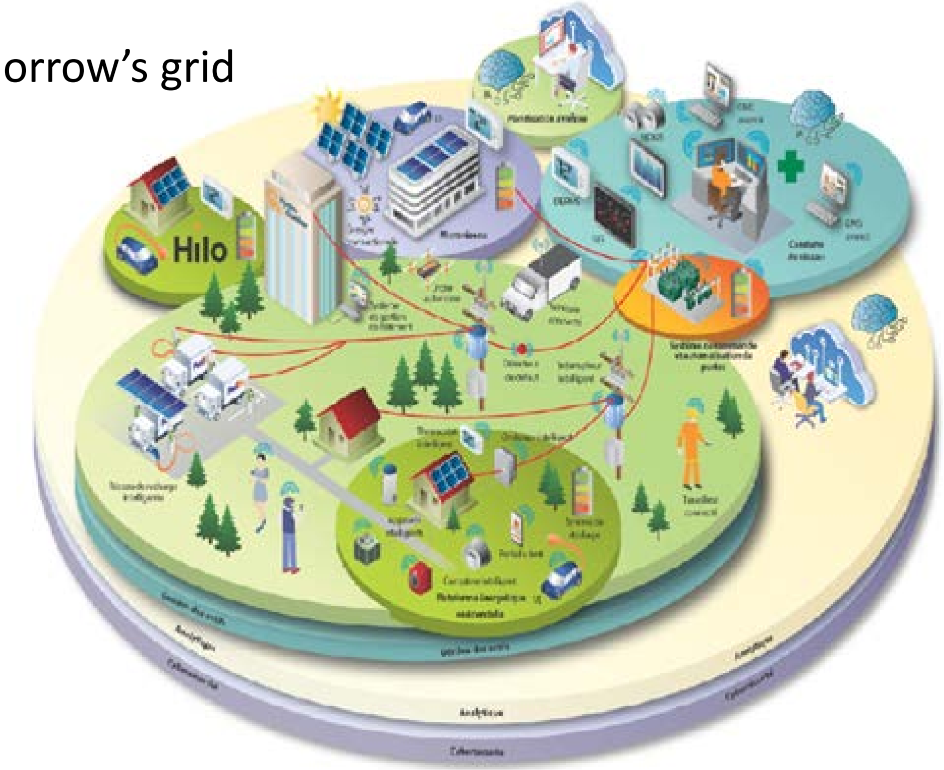
An energy transition is under way, and resources that produce and consume energy are becoming more and more diversified and distributed

- Electric cars
- Smart loads
- Photovoltaic solar generation
- Microgrids
- Energy storage (batteries, accumulators, etc.)
- Virtual Power Plants

Today's grid



Tomorrow's grid

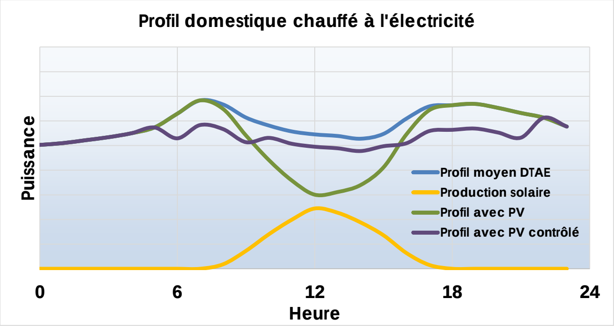


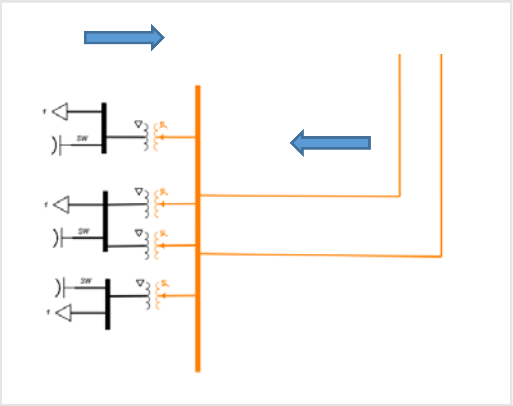
The 2035 grid, HQ distributor's perspective, courtesy of M. Labadie

DERMS – Distributed energy resource management system

Tomorrow's grid will behave differently from today's:

- More intermittent energy resources (wind and solar)
- Increase in load-ramping phenomena
- Relocation of generation resources (traditionally in the north) closer to urban loads
- Bidirectional energy exchanges and flow reversals



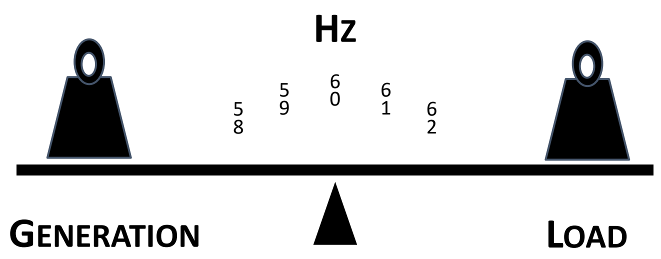


DERMS – Distributed energy resource management system

These changes in behavior impact reliability:

- Demand management
- Voltage control
- Frequency control
- Protection system

Frequency



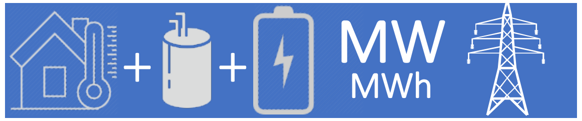
The new distributed energy resources will have to be managed to limit impacts and their costs

DERMS – Distributed energy resource management system

Tomorrow's grid requires innovative solutions, and distributed energy resources can contribute:

- **Integration of distributed smart components opens the door to new services and alternatives to existing services**
- **The goal is to transform these distributed resources into grid services**

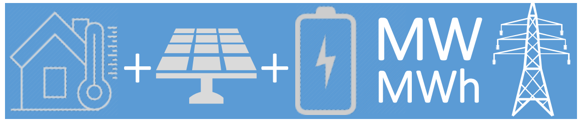
Voltage regulation



Load curtailment

Frequency control

Substation capacity



Recovery after power failure

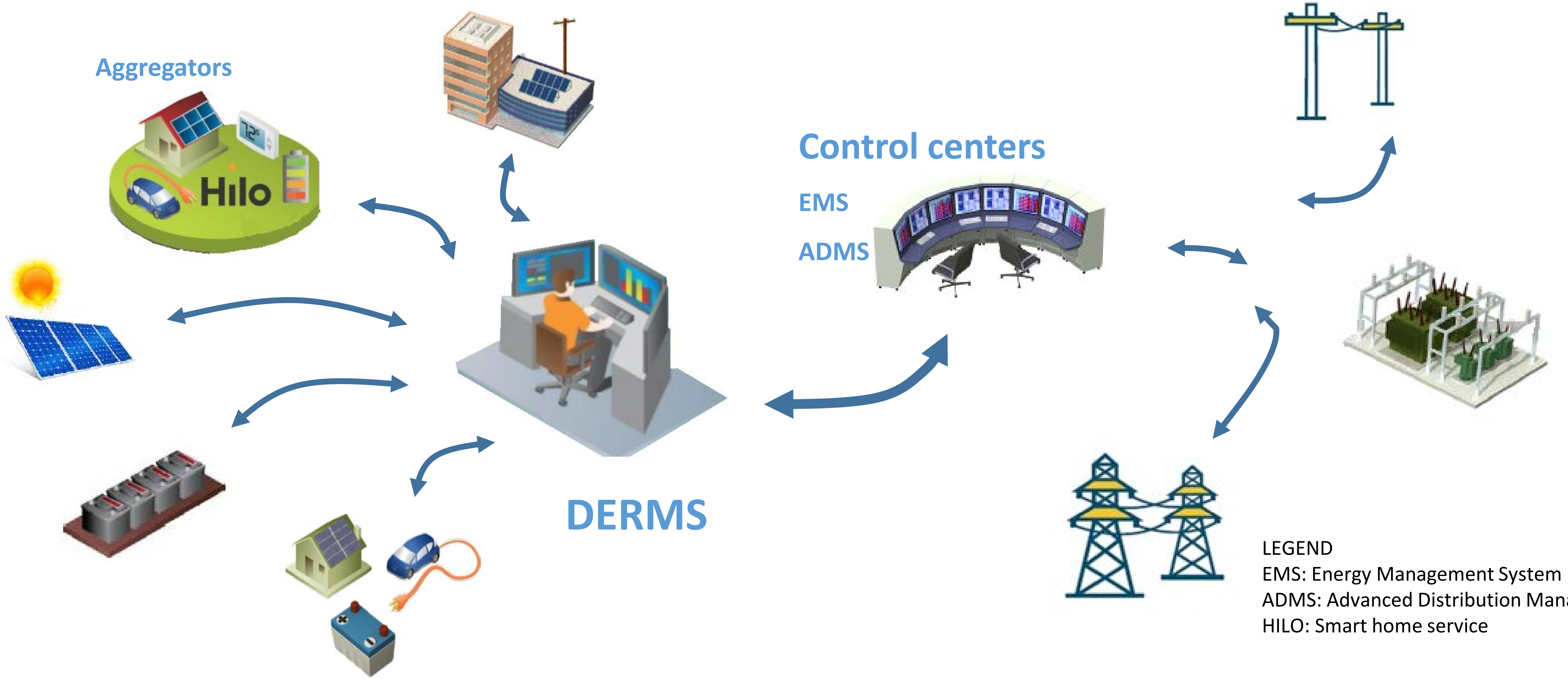
DERMS – Distributed energy resource management system

For transmission grid planning

- Targeted services can contribute to system reliability
- Because of these services, required investments can be avoided or delayed

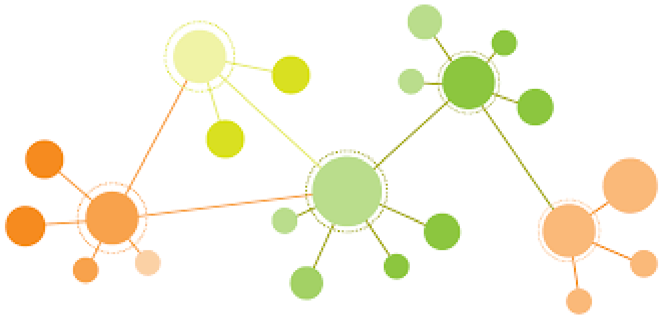
DERMS – Distributed energy resource management system

To achieve this, a management system for visualizing, controlling and optimizing distributed energy resources (DERs) is required



LEGEND
EMS: Energy Management System
ADMS: Advanced Distribution Management System
HILO: Smart home service

DERMS – Distributed energy resource management system



DER visualization

- To know what is on the grid at all times
- To forecast what will happen in the short/medium term
- To make sound decisions (based on the above) that will maintain reliability

DER control

- Required to provide grid services and manage operational emergencies

DER optimization

- For flexibility in managing all resources
- Use of the appropriate resources at the right time and place
- To manage multiple stakeholders (aggregators and customers)
- To contribute to a more probabilistic decision-making approach

DERMS – Distributed energy resource management system

What we want a DERMS to do:

Aggregate resources

- Easier management so grid operators do not get lost in the multitude of resources

Simplify operations

- To allow layers of abstractions in order to discriminate work details according to geographic area or specific grid services

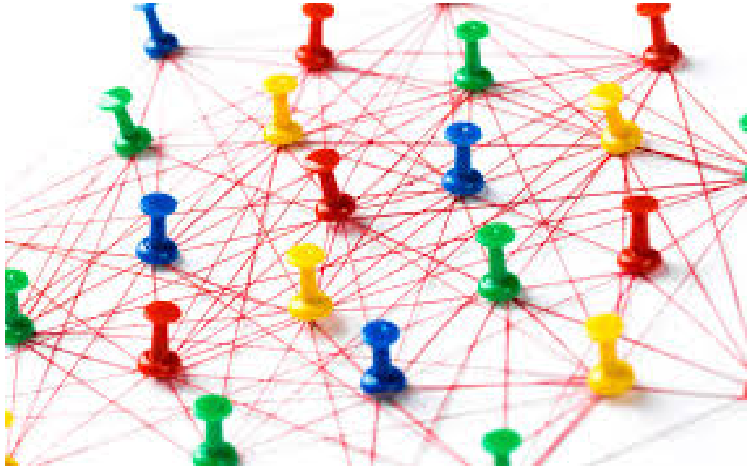
Translate information

- DERs use a wide variety of technologies and recognized communication protocols and standards are required

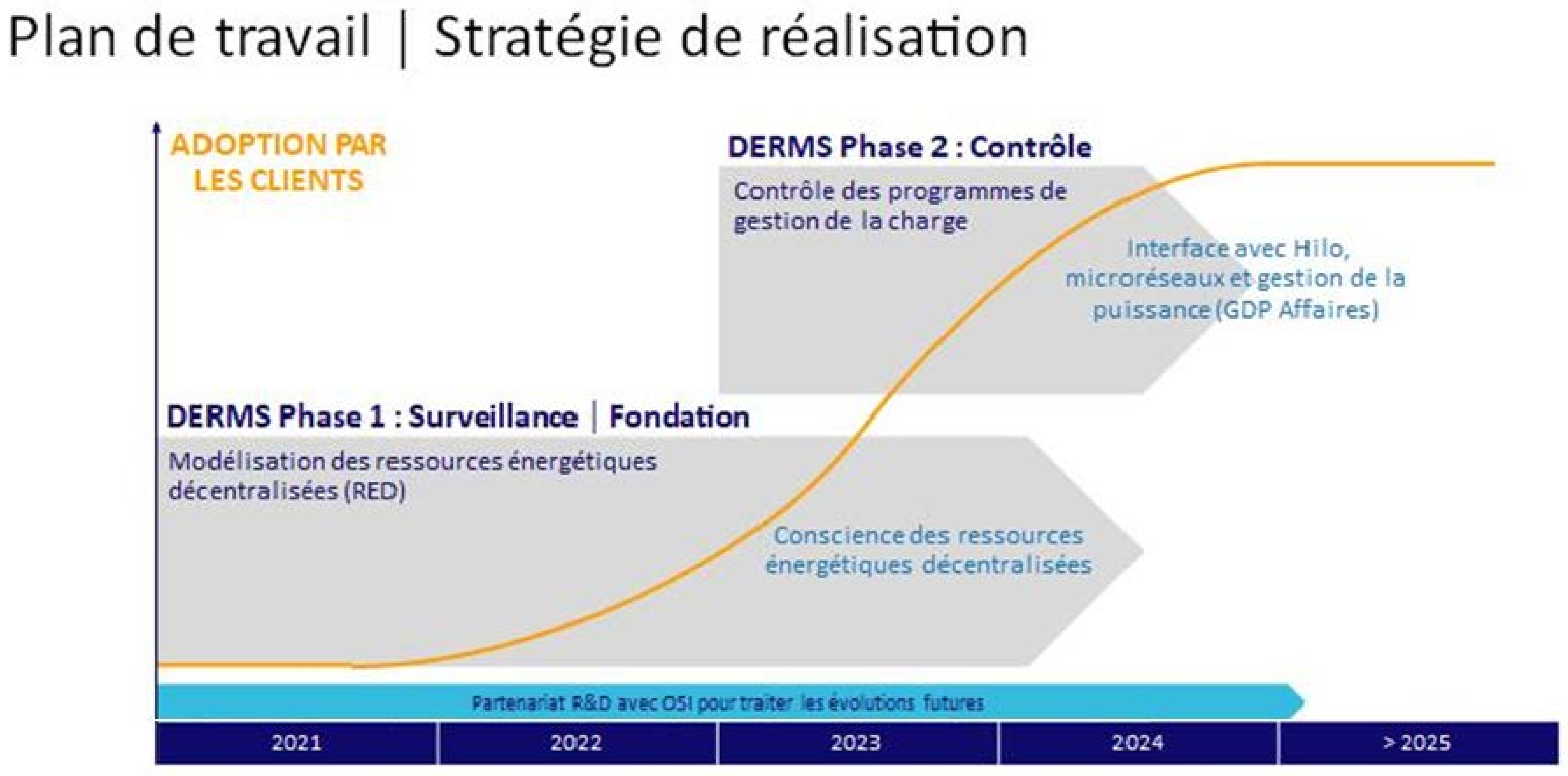
DERMS – Distributed energy resource management system

Issues in introducing a DERMS

- Complexity, speed and quantity of information to be exchanged
- Integration with existing transmission and distribution systems
- Cyber security



DERMS – Distributed energy resource management system



DERMS – Distributed energy resource management system

To summarize:

The grid is evolving and transforming, with growing penetration of distributed energy resources (DERs) expected.

The introduction of a system for managing DERs (and aggregators) is under way in preparation for the energy transition (DERMS)

- This system is necessary to manage the complexity and quantity of DERs
- It also offers new ways to respond to issues on the Hydro-Québec grid

A DERMS is crucial to the operation of tomorrow’s grid